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September, 1935

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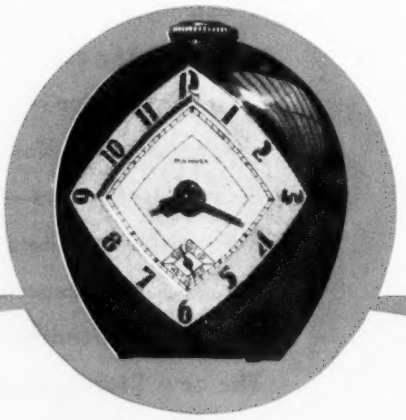

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POWER

A McGraw-Hill Publication—Established 1884
PHILIP W. SWAIN, *Editor*

FURNACES of 1935

FIRE, air and water are the three elements, said the ancient world. Today we know better, but we also know that any man who can master these three has the makings of a first-class power engineer. Certainly fire, air and water are the elements of furnace design.

It's simple enough to make a fire and keep it going with coal, oil or gas. By intimate mixing it's not difficult to maintain an "efficient" fire—one with complete combustion and little excess air. But it's a real trick to confine such a fire in a furnace that will hold its strength and tightness through years of gruelling service.

Because this job is not only difficult, but immensely important to all engineers concerned with steam generation, *Power* presents in this number a summary of today's furnace practice. It starts with refractories, tells how they should be used, shows typical furnace-wall construction, and ends with furnace design.

Water-wall experience has shown the fallacy of the "B.t.u. per cubic foot" as the prime factor in furnace design. Heat released per square foot of exposed water-heating surface is the important ratio, directly related to furnace temperature and furnace "punishment," as shown in curves here published for the first time.

Almost every rule of refractory selection and furnace design is tied to an "if" or a "but." On every hand there is need for judgment, experience, compromise. For example, low first cost is itself an obvious advantage. Yet inexpensive materials and construction may prove most costly, not only in maintenance labor and materials, but also in limitation of capacity and efficiency and the risk of emergency plant shutdown. In the attempt to avoid these one may err almost equally with the motto "nothing but the best"—go beyond the point of economic investment. As far as possible this section points the golden mean of successful experience.

Furnace design is no static art, finished and sealed. Year after year, refractory and furnace engineers burn the midnight oil perfecting new materials, new shapes, new types of construction. To the power engineer this intensive activity means constant progress toward his goal of more dependable power services at lower cost.

No publication can pretend to teach the difficult art of furnace design in 16 pages; it must be a life-long study. We do feel, however, that this section outlines today's best practice in a way that will definitely reinforce the readers' own practical experience.

This is the fourth special-subject section *Power* has published in 1935. The others were Piping in February, Maintenance in April, Diesels in June.

REFRACTORIES FOR BOILERS

This and succeeding articles, prepared by R. B. Purdy, associate editor, will help you select refractories and design the furnace for your boiler

TOO often, furnaces are designed without regard to conditions imposed upon the furnace wall, and later a vain search is made for a refractory that will stand the unnecessarily severe service. For best results, furnace design and refractory selection should go hand in hand. Even so, experience and judgment are necessary to balance opposing qualities in boiler refractories and to estimate service conditions.

Refractory service conditions are influenced by kind of fuel, volume of furnace, ratio of cooled surface to uncooled refractory, type of firing, excess air, furnace draft, chemical composition and fusion temperature of the fuel ash, velocity of gas next to the wall or arch, height of setting and rate of heat liberation. These various factors determine temperature of the refractory and likelihood of trouble from slag erosion or adhesion and certain types of spalling.

Temperature of the fire face of a refractory wall seldom exceeds 2,800 deg. and is usually less than this in underfeed-stoker installations. It can not be said that refractory temperatures will be high in boilers operated with high heat liberation per cubic foot of furnace volume, though in any given boiler, temperature increases with rate of heat liberation. For example, temperature measurements in two boilers, one fired with oil at a heat release of 63,000 B.t.u. per cu.ft. and the other fired with pulverized coal with a heat release of 12,000 B.t.u. per cu.ft., showed in each case a maximum refractory temperature of 2,700 deg. Radiation from walls to cooler surfaces and flame impingement both affect refractory temperatures to a great degree. For a very high-set boiler, refractory temperatures will likely be higher than in a lower-set unit because the refractory sees less water-cooled surface.

Refractories are subjected to very rapid temperature changes when firing up or banking a boiler. Measurements in a 13½-in. wall of a pulverized-coal-fired furnace showed a rise to 900 deg. 10 min. after lighting the burners and to 2,100 deg. in 1 hr. On banking, the face temperature fell from 2,275 to 1,950 deg. in 10 min. Although refractories are relatively good heat conductors, nevertheless the high face temperature penetrates only a few inches. With a face temperature of 2,800 deg. the temperature 2 in. in for a 22½-in. refractory wall would be about 2,500 deg. after thermal equilibrium is established. The temperature gradient is important, for while it limits severe temperature to the face of the refractory it causes unequal expansion through the wall structure.

Velocity of gases in furnaces varies over a wide range. In underfeed-stoker and pulverized-coal installations, velocities range from 5 to 25 ft. a second in various parts of the furnace. Highest velocity occurs just above the fuel bed. With chain-grate stokers much higher velocities are encountered, ranging from 10 to 60 ft. a second. Gases at the higher velocities carry with them particles of ash and erode the brickwork when it is at high temperature.

Characteristics of the slag formed from the ash in the fuel burned is the principal factor governing the maximum allowable temperature in a furnace. For each combination of slag and refractory there is a temperature above which brick walls are rapidly eroded. Some engineers fix this critical temperature at the softening temperature of the slag.

Coal Ash Slags

Softening temperature of coal ash varies from 2,000 to 3,000 deg. Coal-ash slags are classed as acid slags, and their softening temperature are usually lower than that of the ash from which they are formed. Coal-ash slags and refractories contain similar materials, and because of this, softened or fluid slag readily adheres to the wall and may enter into combination with the brickwork.

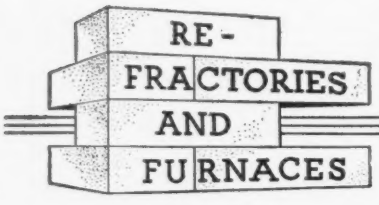
Slags are of two general types—those that adhere to the wall, forming a coating of increasing thickness, and those that flow over the wall, leaving only a thin coating. Slags of the first type damage the refractory only when they are removed during cleaning. The flowing slag of the second type usually combines with the refractory and corrodes or erodes the wall.

Refractory materials used in boiler furnaces to meet the service conditions outlined are fireclay, kaolin, diaspore, cyanite, silicon carbide and chrome.

First-quality firebrick are made of fireclay having an alumina content of about 40% and fusion temperature of 3,000 to 3,100 deg. Second- and third-quality firebrick have lower alumina content and lower fusion temperature and should never be used in lining combustion chambers.

Kaolin is used in the manufacture of super-refractory brick that are very dense, have an alumina content of 43 to 45% and a fusion temperature of 3,100 to 3,250 deg. To avoid volume changes in service, brick of this material have a high percentage of precalcined kaolin and are burned at higher temperature than fireclay brick.

Cyanite and diaspore are used mixed with fireclay to give special refractories of high alumina content. By varying the amount of fireclay used, the alumina content in the resulting brick can be governed. Special brick containing 50, 60, 70 and 80% alumina are standard products with many refractory manufacturers. The fusion temperatures for such brick are respectively



3,200 to 3,250 deg., 3,290 to 3,300 deg., 3,335 deg. and 3,389 deg. Early high alumina brick gave trouble from shrinkage, but recent developments have eliminated this difficulty.

Diaspore is used almost entirely for these special refractories, because cyanite has to be imported from India, hence is too expensive. This type of refractory has given some trouble from spalling, but in the two lower grades the spalling tendency has been greatly reduced, and in fact some of the diaspore refractories now show high resistance to spalling. They have excellent resistance to the slagging action of ash of high basic oxide content but are fluxed by coal slags having a high percentage of lime. High-alumina brick are practically inert to the influence of CO, and SO_2 weakens them less than it does fireclay brick.

Silicon carbide is a product of the electric furnace. It is a compound of silicon and carbon produced at a temperature in excess of 4,000 deg. It is formed into refractory brick and shapes by bonding selected grain sizes with small percentages of refractory bonds. A silicon-carbide brick contains in excess of 85% SiC. Characteristics of brick made of this refractory are strength at high temperature, density, resistance to abrasion, infusibility, low spalling, uniformity of size, high thermal conductivity—the latter quality making this refractory suitable as a facing material on water-cooled walls. It maintains practically its full crushing strength to 2,462 deg. and at a temperature of 3,092 deg. shows no evidence of softening under a compressive load of 175 lb. per sq.in. In reducing atmospheres, silicon-carbide refractory is practically unaffected by slags, and for this reason is often used at the clinker line in stoker-fired furnaces. In an oxidizing atmosphere, as occasionally occurs in the upper portion of a furnace, oxidation begins at temperatures as low as 1,550 deg., causing gradual growth or permanent expansion. Likewise, under this condition it is decomposed at ordinary furnace temperatures by slags high in iron. If air is present, silicon carbide should be cooled to take advantage of its slag resistance.

Most Neutral Refractory

Chrome is being used for high-temperature cements and as a plastic refractory on water walls and furnace bottoms. It is not used in boiler furnaces in brick form because of its high spalling characteristics. It is the most neutral refractory known, hence is highly resistant to slag erosion. Its fusion temperature ranges between 3,400 and 3,700 deg.

Plastic fireclay refractories have a considerable field of usefulness for repairing boiler settings, especially around doors, burners, and other places where special shapes are used. They are also used for completely lining a furnace, giving a monolithic structure. To get the most satisfactory results from plastic refractory used as a furnace lining, it is essential that it be installed by masons who have had extensive experience with its application. Likewise provision should be made for expansion by building the wall in panels. There is also now available an air-set refractory that can be poured like concrete into a form and is claimed to be designed for operating temperatures of 3,000 deg.

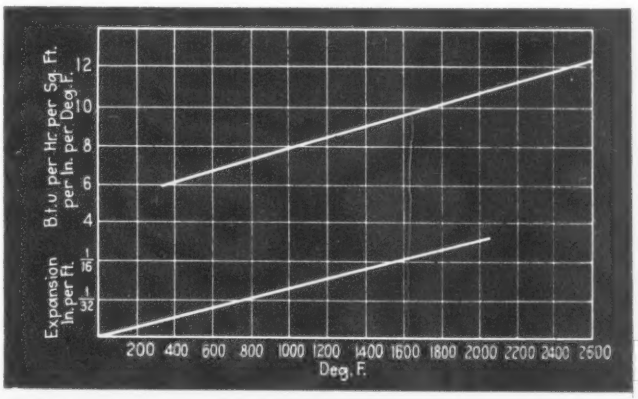
Recent development has brought out light-weight insulating firebrick suitable for continuous exposure at temperatures up to 2,900 deg. with fusion temperatures of about 3,200 deg. Panels with $4\frac{1}{2}$ in. of insulating firebrick have a heat flow of about 350 B.t.u. per sq.ft. per hr. with a hot face temperature of 1,800 deg. It is claimed these insulating brick may be used as furnace lining in oil- or gas-fired installations and in coal-fired furnaces where they will not be subjected to the action of slag or mechanical abrasion.

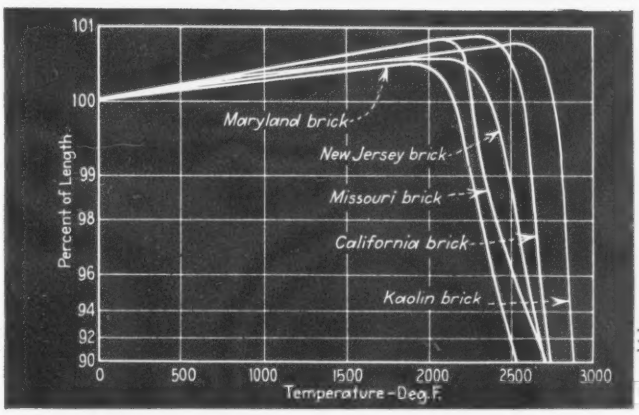
Selecting Refractories

When selecting refractories, fusion temperature is of secondary importance. This temperature is never reached in boiler furnaces, and first-quality brick rarely fail from actual fusion unaided by fluxing with slag. Of much greater importance is the ability of the refractory to stand load at high temperature. Load-carrying ability of firebrick is influenced by the quality of the fireclay, density of the brick and temperature at which it is burned in the kiln. Dense, hard-burned brick usually have greater strength than softer-burned brick containing a high percentage of flint clay. Load tests are made by subjecting the brick to 25 lb. per sq.in., raising the temperature, and noting per cent deformation. Fireclay brick subjected to this test usually expand up to a certain temperature and then deform rapidly as shown by the curves in Fig. 2.

Chemical analysis of brick tells the engineer practically nothing about its characteristics, particularly with respect to its fluxing action with fuel-ash slag and its

Fig. 1 (Top)—Thermal expansion and conductivity of average fireclay. Fig. 2—Deformation of fireclay bricks under load of 25 lb. per sq.in. at various temperatures





consequent ability to withstand slag erosion. The damaging action is not only influenced by the respective compositions of the refractory and ash but also by the temperature and furnace atmosphere in contact with the wall. If this is high in CO and low in O the fluxing temperature is generally much lower. Generally speaking, a dense brick withstands slag action better than a porous brick. Coating the walls with chrome mortar and using chrome in laying up the brick has in some instances proved beneficial. Chrome and silicon carbide withstand slag better than any other boiler refractory.

Spalling

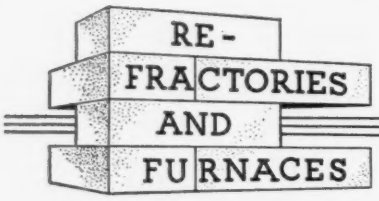
Spalling, which is the breaking away of solid pieces from the fire side or end of the brick, may be due to one or more of several causes. One cause of such wastage is the volume change caused by the rapid temperature fluctuation occurring when firing up or banking a boiler. Usually porous or less-dense brick of soft burn give less trouble with spalling from this cause than do dense brick. The porous structure distributes the stresses and permits a large portion of the expansion to be taken up within the brick. But a new development has resulted in a very dense super-fireclay brick that has good spalling characteristics. Likewise, lack of uniformity in the refractory material may cause a porous brick to spall more than a denser brick.

When slag forms on a brick it sometimes penetrates into the brick a considerable distance, forming a very brittle section which may easily rupture or spall when subjected to any strain. The more porous the brick the more readily it is penetrated by molten slag and the greater the tendency to spall from this cause.

Another cause of spalling is pinching of the fire ends of the brick when insufficient clearance for expansion has been allowed. It should be borne in mind that the temperature of the fire end of the brick is materially higher than the rest of the brick and that it consequently expands more than the rest of the brick. If the brick does not reach the softening temperature before the load becomes too great, relief must be obtained by failure in such a way as to relieve the strain. Consequently, other factors being equal, brick having the highest expansion and least uniform rate of attaining their maximum expansion are most susceptible to spalling when subjected to rapid heating and cooling.

From the foregoing it is evident that there is no "cure-all" or "best" refractory. To resist certain furnace conditions, a dense brick may be best, while for other conditions a more porous brick is indicated, and both conditions may exist in the same furnace at the same time. Where conditions are severe, as in oil furnaces, brick with higher fusion temperature and load-bearing characteristics may be required, but in all cases the brick resulting in the lowest total cost, including maintenance, should be used.

The details of laying up of brick and design of furnace have a great influence on the life of a refractory setting and will be discussed in succeeding articles.



WHAT'S NEW

FIVE steps are commonly taken in the manufacture of fireclay refractories, namely, (1) grinding and screening, (2) mixing, (3) pressing or molding, (4) drying, (5) burning. Spurred by the increasing use of water walls, refractory manufacturers are actively developing improvements in these processes.

In grinding refractories, it was formerly considered sufficient to reduce the raw or calcined material to some upper limit of coarseness. Recently, a number of very dense refractories have been developed by combining in definite proportions certain bands of grain sizes.

Early demands for dense brick brought in the dry-press method of molding with mechanical presses which it was thought produced pressures of 5,000 lb. per sq.in., but which more often operated at 1,500 lb. Press pressures today have recently reached 10,000 lb. per sq.in., which has brought with it a problem of deaerating the clay to prevent re-expansion when pressure is released. Various methods are: slowing down rate of applying pressure, double pressing, and use of vacuum.

Improvements in mixing have been made where the amount of plastic material is low, as in the dry-press method. This has been accomplished by use of mixing mills in which the wheels are mounted very close to the center of the bed of the pan. This causes an increase in the shearing effect of the wheels and more effectively coats the plastic with the non-plastic material.

In burning, there is a trend towards increased pre-calcining to develop a mix with high crystallinity—in fireclay, kaolin and diaspore, development of mullite is the goal. (Mullite is the technical term for a chemical combination between 72% alumina and 28% silica in the clays brought about at a certain temperature.)

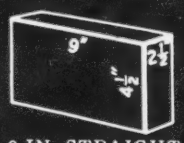
Many refractories intended for high heat now contain clays in which the pre-calcining temperature has been increased; one brand of kaolin in which mullitization is well advanced contains clay pre-calcined at 3,002 deg. (Pre-calcining is pre-burning to prevent later shrinkage during manufacture.)

The highest point in the development of fireclay brick is represented by various super-duty bricks. Their chief characteristics are high density and volume stability which contribute to increased slag and spalling resistance.

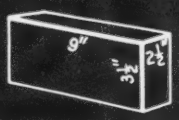
The trend in the search for better high-aluminum refractories has been for a material which can be converted to nearly 100% mullite crystal. Cyanite approaches such a material and lately there is an increase in the use of Indian cyanite for this purpose because of its purity.

Important among new developments are the improvements made in insulating firebrick, brought to the point where they are recommended for use as a furnace lining in locations not subject to slag or abrasion. A castable mixture with hydraulic set is also available. A somewhat greater development has been made in the refractories applicable to other than boiler furnaces.

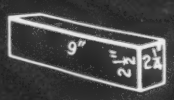
37 STANDARD 9-IN. FIREBRICK SHAPES



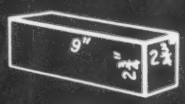
9-IN. STRAIGHT
9x4½x2½ in.



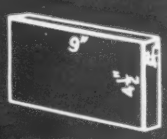
SMALL 9-IN. BRICK
9x3½x2½ in.



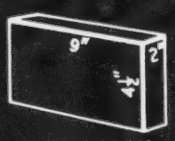
SOAP
9x2½x2¼ in.



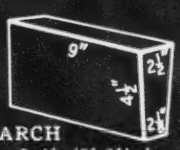
CHECKER
9x 2¾ x2¾ in.



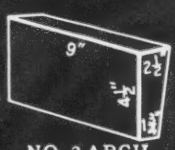
SPLIT BRICK
9x4½x1½ in.



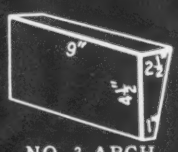
2-IN. BRICK
9x4½x2 in.



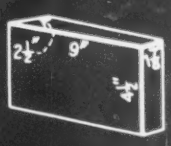
NO. 1 ARCH
9x4½x(2½-2½) in.
76 brick to the circle
4¼ ft. I.D.; 5 ft. O.D.



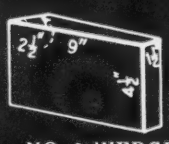
NO. 2 ARCH
9x4½x(2½-1¾) in.
38 brick to the circle
1¾ ft. I.D.; 2½ ft. O.D.



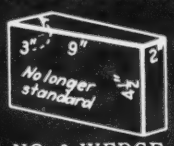
NO. 3 ARCH
9x4½x(2½-1) in.
19 brick to the circle
6 in. I.D.; 1¼ ft. O.D.



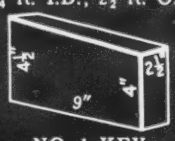
NO. 1 WEDGE
9x4½x(2½-1⅞) in.
91 brick to the circle
4½ ft. I.D.; 6 ft. O.D.



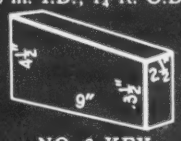
NO. 2 WEDGE
9x4½x(2½-1½) in.
57 brick to the circle
2¼ ft. I.D.; 3¼ ft. O.D.



NO. 3 WEDGE
9x4½x(3-2) in.
57 brick to the circle
3 ft. I.D.; 4½ ft. O.D.

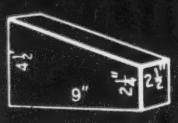


NO. 1 KEY
9x(4½-4)x2½ in.
113 brick to the circle
12 ft. I.D.; 13½ ft. O.D.



NO. 2 KEY
9x(4½-3½)x2½ in.
57 brick to the circle
5½ ft. I.D.; 6½ ft. O.D.

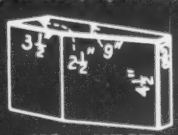
NO. 3 KEY
9x(4½-3)x2½ in.
38 brick to the circle
3 ft. I.D.; 4½ ft. O.D.



NO. 4 KEY
9x(4½-2½)x2½ in.
25 brick to the circle
1½ ft. I.D.; 3 ft. O.D.

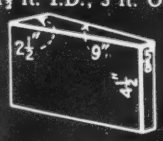
FEATHER EDGE
9x4½x(2½-⅛) in.

JAMB BRICK
9x4½x2½ in.

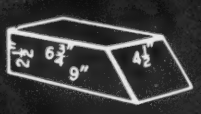


NO. 1 NECK
9x4½x2½x3½x⅞ in.

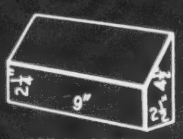
NO. 2 NECK
9x4½x2½x1½x⅞ in.



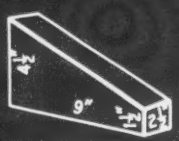
NO. 3 NECK
9x4½x(2½-⅝) in.



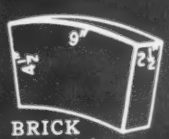
END SKEW
(9-6¾)x4½x2½ in.



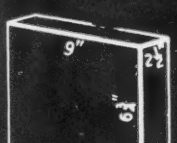
SIDE SKEW
9x(4½-2½)x2½ in.



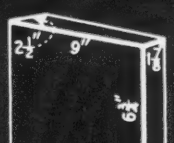
EDGE SKEW
9x(4½-1½)x2½ in.



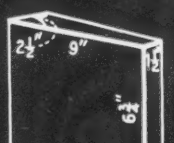
CIRCLE BRICK
9x2½x4½ in.
12 to 45 brick to the circle
24 to 120 in. I.D.;
33 to 129 in. O.D.



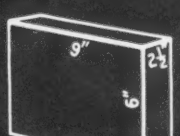
LARGE 9-IN. STRAIGHT
9x6¾x2½ in.



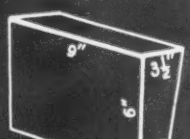
LARGE 9-IN. NO. 1 WEDGE
9x6¾x(2½-1⅞) in.
91 brick to the circle
4½ ft. I.D.; 6 ft. O.D.



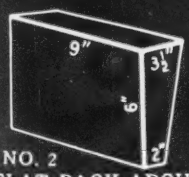
LARGE 9 IN. NO. 2 WEDGE 9x6¾x(2½-1½) in.
57 brick to the circle
2¼ ft. I.D.; 3¾ ft. O.D.



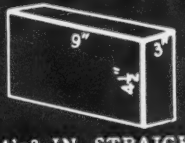
FLAT BACK STRAIGHT
9x6x2½ in.



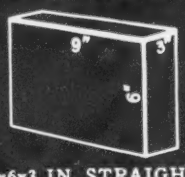
NO. 1 FLAT BACK ARCH
9x6x(3½-2½) in.
2½ ft. I.D.; 3½ ft. O.D.



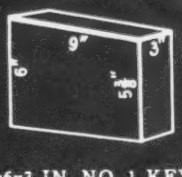
NO. 2 FLAT BACK ARCH
9x6x(3½-2) in.
1 1/3 ft. I.D.; 2 1/3 ft. O.D.



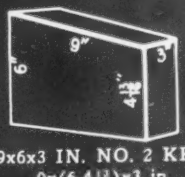
9x4½x3 IN. STRAIGHT



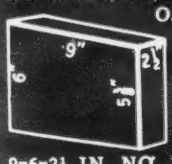
9x6x3 IN. STRAIGHT
Also 9x6x2½ in.



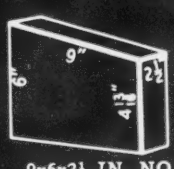
9x6x3 IN. NO. 1 KEY
9x(6-5⅜)x3 in.
91 brick to the circle
12 ft. 11 in. I.D.; 14 ft. 5 in. O.D.



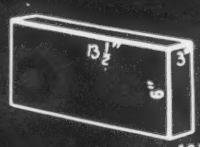
9x6x3 IN. NO. 2 KEY
9x(6-4⅛)x3 in.
48 brick to the circle
6 ft. 1 in. I.D.; 7 ft. 7 in. O.D.



9x6x2½ IN. NO. 1 KEY
9x(6-5⅜)x2½ in.
91 brick to the circle
12 ft. 11 in. I.D.; 14 ft. 5 in. O.D.

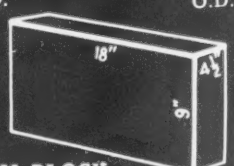


9x6x2½ IN. NO. 2 KEY
9x(6-4⅛)x2½ in.
48 brick to the circle
6 ft. 1 in. I.D.; 7 ft. 7 in. O.D.



13½ IN. STRAIGHT
13½x6x3 in.
Also 13½x6x2½ in.

TWO SPECIAL SIZES



BOTTOM BLOCK
18x9x4½ in.

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HOW TO LAY UP REFRACTORY

Construction details of a boiler setting are as important in low furnace maintenance as a good refractory

THE best refractory may be made worthless if the setting in which it is used is improperly built. Consequently, considerable study should be given to details of construction if the most is to be gotten out of the refractory and furnace. Specifications and detail drawings should be prepared, removing from the foreman mason's judgment the decision of how brick shall be laid and bonded, where and how to construct expansion joints and arches, etc. Such specifications and drawings not only help the setting contractor, but also are great aids to the engineer who inspects the work.

Conditions existing in a furnace wall are so different from those in other masonry that boiler settings should be constructed only by masons who have had extensive experience with this kind of work. From the point of view of the mason, the most important of these special factors are expansion (which is different in different parts of the boiler and also throughout the wall thickness), air-tight construction, and variation in brick size from specified dimensions. Incidentally brick variations over 2% plus or minus from specified length, width and thickness should not be tolerated.

Laying Up Firebrick

How should firebrick be laid? Experience indicates that best results are obtained when brick are placed as closely as possible. One course should be laid at a time and care should be taken to see that it is level. This may be done either by rejecting brick thinner or thicker than those already laid or by rubbing each course with silicon-carbide brick or other abrasive until a substantially plane and level surface is obtained.

Considerable difference of opinion exists as to whether fireclay or high-temperature mortar should be used as a bonding material. Those who advocate fire clay claim each brick has a better opportunity to expand and that there is less likelihood of chemical reaction between brick and bonding material when the fire clay used is similar to that used in the brick. Those who advocate high-temperature mortars claim a more monolithic-like structure of greater strength.

When fireclay bond is used, a good mix consists of 60% calcined clay and about 40% raw clay, all passing through a 40-mesh sieve. Water should be added until the mixture has the consistency of thick cream or so that the joint is less than $\frac{1}{16}$ in. thick. Each brick should be dipped into the fireclay mix and then pushed sideways into place so as to work the bond into irregularities in the face of the brick. When the brick is in place it should be tapped with a hammer to make sure the joint is as thin as possible. By laying brick in this manner, it is seldom necessary to use a dipper to pour fireclay batter over the brick. "Buttering" of brick should not be permitted. When high-temperature mortar bond is used the procedure is the same, except that with chrome mortar slightly thicker joints are permissible.

In laying up brick be sure to stagger all joints. Vertical joints should not come one above another, and joints extending straight through the wall should not be permitted. Voids in the wall filled with fireclay should not be permitted, they prevent a proper bond in the center of the wall where it is most needed.

Transverse bonding of the wall is important for

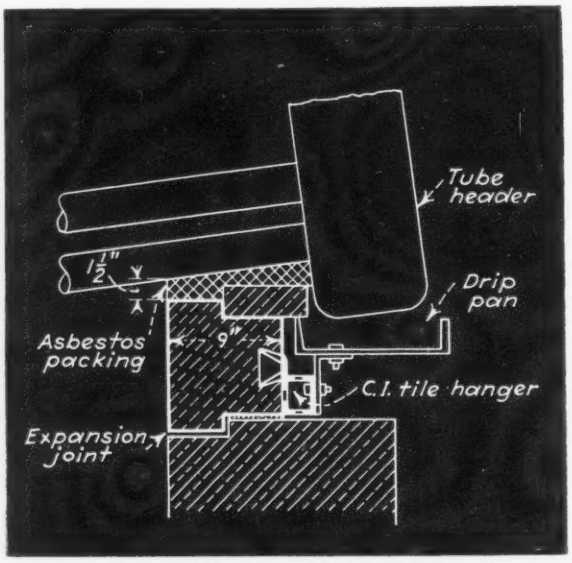

Fig. 1—Protecting the header of a straight-tube boiler

structural strength. The strongest transverse bond is the Old English bond of alternate header and stretcher courses. But this arrangement makes it hard to replace the firebrick lining and is little used in furnace brick work. In places where replacements are not likely, such as behind boiler tubes, this bond can be used to advantage. A bond construction that permits easier replacement is shown in Fig. 6. This is a running bond for a wall having 9 in. of first-quality brick lining and 9 in. of second-quality brick. First-quality brick are laid three header courses and a stretcher and the second-quality bricks are laid three stretchers and a header. Note transverse bonding at every fourth course by headers stepping down from inside to outside of wall. Also note that all vertical joints are staggered. Walls with four header and a stretcher are also used a great deal.

This brings up the question of wall thickness and composition. For structural stability a wall $13\frac{1}{2}$ in. thick should not be higher than 10 ft., an 18-in. wall may be built up to 26 ft. in height and a 22-in. wall to

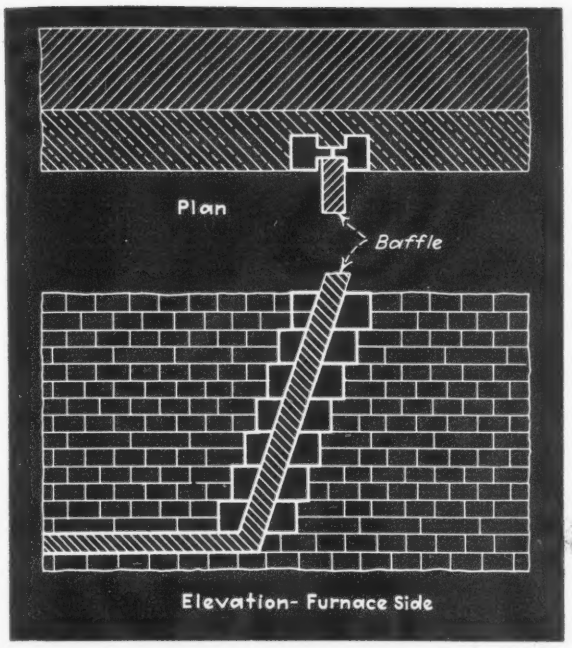

Fig. 2—Special shape to help make inclined baffle tight at wall

35 ft., if of first-quality brick, and to 40 ft. if of super or special refractory. Furnace linings should never be less than 9 in. Many engineers prefer walls of first-quality refractory throughout their thickness, but for thick walls this seems rather wasteful. Red or common brick for the outer part of medium high walls have been used successfully but for very high walls it is not considered good practice as differential expansion is often enough to break the bond between the two parts of the wall and so disrupt the structure. This also applies to insulating brick; they should never be tied into the outer part of the wall. When insulation is used it should be supported separately from the brick of the setting.

Provide for Expansion

To provide for expansion in boiler-setting construction is no easy task. This expansion takes place in three directions — vertically, horizontally along the plane of the wall and at right angles to it. Vertical expansion is always upward and is usually easy to provide for by allowing the wall to move upward freely without coming in contact with steel work or being hindered by beams embedded in the wall and tied to building steel. Sometimes vertical expansion gives trouble, as for example when one end of a side wall is exposed to the furnace while the other end is behind boiler tubes. The higher temperature of the part exposed to the furnace makes this portion of the wall expand more and so tends to lift the cooler part with it, often causing a large diagonal crack in the cooler part of the wall. When this condition exists, trouble can be avoided by building a vertical expansion joint as nearly as possible at the dividing line between the differing temperature zones.

As a wall heats up it expands (about $\frac{1}{18}$ in. per foot) toward each end. It is obvious that in case of a wide wall large forces are required to push great masses of masonry bodily toward an expansion joint. Experience has shown expansion joints should be placed every 5 or 6 ft. to avoid forces that might crush the brick or buckle the wall. Figs. 4 and 7 shows how such joints are constructed. The space left in the joint should be 1 to $1\frac{1}{2}$ in. if high-temperature air set mortar is used and $\frac{3}{4}$ to $1\frac{1}{4}$ in. if fireclay is used in the joints. It should be packed loosely with asbestos or mineral wool to stop air leakage. Don't allow the joint to be filled with fireclay or high-temperature cement. The action of slag sometimes pulls the brick loose at such joints, but special-shaped interlocking tile as in Fig. 7 are available to prevent this. Expansion joints should be made vertical as in Fig. 4.

Opinion differs regarding the location of expansion joints. Some recommend using joints only in the wall away from the corners; others recommend joints both at the corners and in the walls. Those who oppose corner joints maintain that they weaken the structure; those who favor them point out that they allow for difference in vertical expansion of front and side walls.

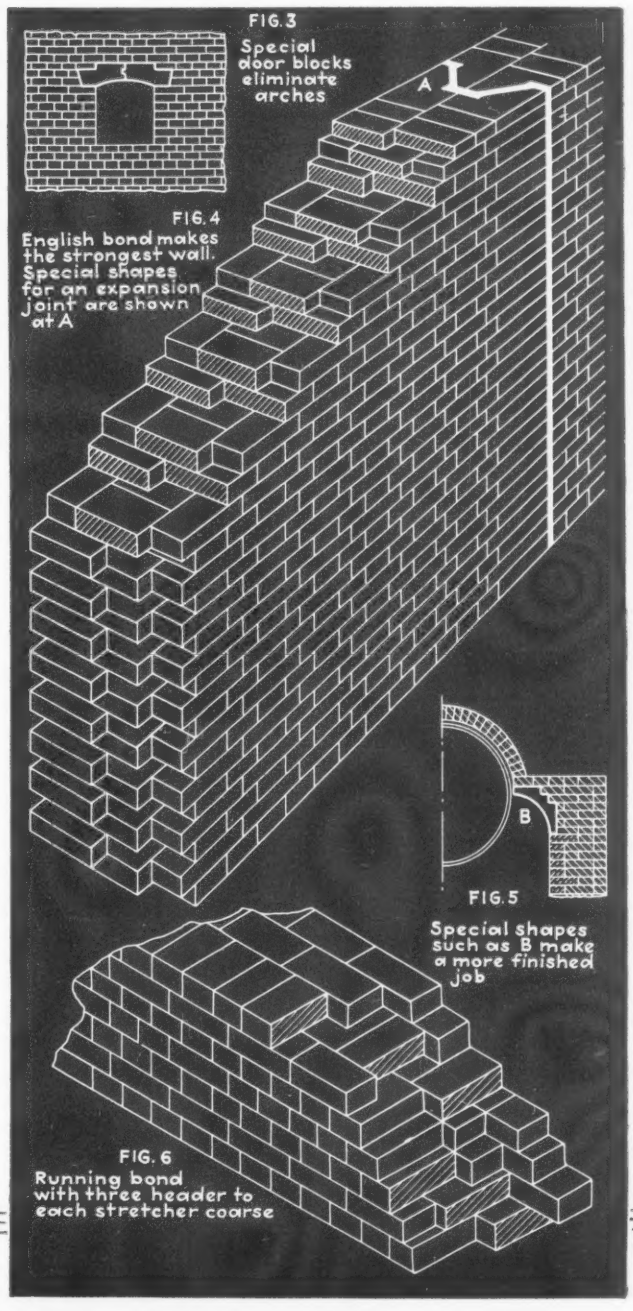
FIG. 3
Special door blocks eliminate arches
A
FIG. 4
English bond makes the strongest wall. Special shapes for an expansion joint are shown at A
B
FIG. 5
Special shapes such as B make a more finished job
FIG. 6
Running bond with three header to each stretcher coarse

It is usual practice to extend bridge walls into the side walls, leaving space at the ends for horizontal expansion.

Buckstays prolong the life of boiler settings. When possible they should be placed in back of expansion joints. They should be in place before the wall is built so it may be built to the buckstay, thus obtaining a firm bearing over its full length. All steelwork should, of course, be outside of walls of masonry type. When for any reason this becomes impossible, space should be provided for air to circulate and for expansion of the setting.

Relieving High Walls

In very high-set boilers the load imposed upon the lower brick may be sufficient to deform them at the high operating temperatures. This condition should be avoided. One method is to relieve the lower portion by supporting the upper part of the wall on a sprung arch. Such arches are sometimes also used to permit replacing the lower part of a wall without disturbing the upper portion, which usually has longer life. Substantial support must be provided for the ends of such arches and buckstays or other steel placed to take the thrust. The skew pack should be out of the furnace. Provision must be made for free vertical expansion of the lower part of the wall, or the purpose of the arch will be lost. This is commonly done by leaving space packed with mineral wool or asbestos. Such arch construction is quite difficult, and often does more harm than good. It should be avoided.

Fig. 7—Expansion joints should be staggered and may be placed as shown in the plan

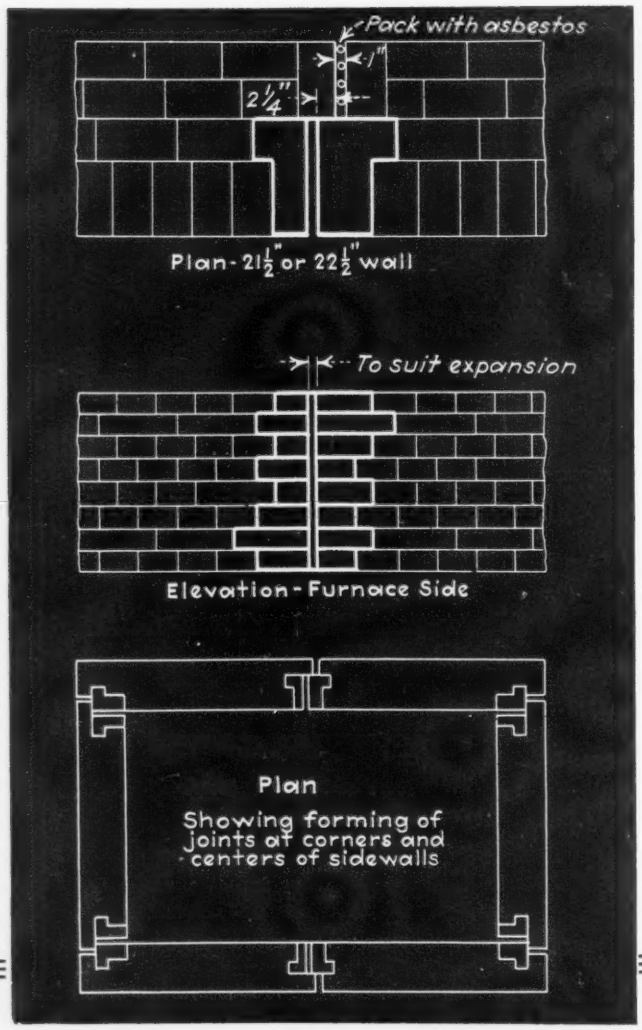
Pack with asbestos
1"
2 1/4"
Plan - 21 1/2" or 22 1/2" wall
To suit expansion
Elevation - Furnace Side
Plan
Showing forming of joints at corners and centers of sidewalls

Fig. 8 shows another method of relieving walls. This construction has been frequently used in front walls to reduce the weight of brick supported by underfeed stokers. The upper portion of the wall must always be outside of the furnace. To prevent slag and ash getting into the joint between the walls a ledge should be built as shown. It also is good to insert special tile, as at *A*, which can be tied back to the steel work. A soft packing should be used in the joint for an air seal. This construction prevents the wedging action from pushing the top portion of the lower wall into the furnace.

Arches over door openings and over stokers should be constructed of soldier (bricks standing on end) courses or wedge brick rather than two row lock (brick laid on side) courses. This permits more arch to burn away before it fails. When looking at a plan view, the bond should be obtained by alternate use of 9-in. straight or wedge brick with large brick (9x6¾x2¼ in.) at the face of the arch near the fire. By using the large brick there will be no brick less than 9 in. straight in the arch facing the fire.

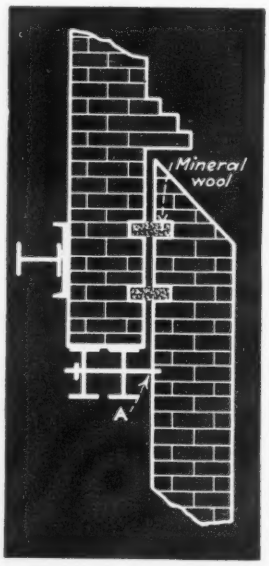

Fig. 8—Method of relieving lower wall of too much weight

Many special-shaped tile are available for use in boiler settings. Their use improves the setting and often decreases cost by decreasing construction time. Examples of a few such shapes are shown in Fig. 1, 2, 3, 4, 5, 7. Dimensions of special shapes should be multiples of the dimensions of standard brick plus $\frac{1}{16}$ in. for each joint replaced.

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SUSPENDED WALLS AND ARCHES

Selection of a suitable arch or wall construction from the many types available is not easy. Here are features to consider

SUSPENDED refractory walls, examples of which are shown on the following pages, offer several advantages over solid refractory walls. Although first cost is higher, repairs are lower because less refractory has to be replaced and the work can be done more easily and quickly. The refractory carries less load, hence can operate at higher temperature, and more positive means for expansion are provided.

Suspended walls are designed so they may be used either as air-cooled walls, insulated walls without air cooling, or as insulated refractory walls behind bare-tube water walls.

Several features of suspended-wall construction should be investigated when such walls are considered. These features apply also to suspended arches such as those used for chain-grate stokers. They may be classified under two headings—features affecting installation and repair and features affecting wall performance.

Usually certain portions of a wall or arch are subjected to more severe service than others. Refractory at these points erodes or spalls, making replacement necessary, while the rest of the wall may be in good condition. The spalled or eroded refractory in a suspended wall or arch can be removed and replaced. Attention should be given to the ease with which this can be done, without disturbing the rest of the wall. The process of locating and placing the supporting castings and placing the tile on the supports should be sufficiently flexible to accommodate variations in tile dimension. The supporting castings should be flexible, yet at the same time make a stable and lasting structure.

Special tile shapes are available made from almost any grade or type of refractory required to meet the furnace conditions.

How Much Refractory?

Depth of refractory between the furnace and the nearest supporting metal is a measure of the amount of refractory that can be worn away before replacement is necessary, hence is a factor in the life of the wall. But too much refractory is not good either, as it will decrease heat flow and so defeat the purpose of the air-cooled wall. Air should circulate around the supporting castings, and a minimum of metal should be embedded in the tile.

Note that in some of the walls air can circulate horizontally, while in others circulation is only vertical. This may or may not be important, depending on the arrangements for taking off the hot air.

When insulation is applied, the temperature of the wall up to the insulation is considerably raised. Provision should be made to cool the castings or they should be of material that will withstand the higher temperature. Insulation is not generally applied to arches, the tops of which should be left open to permit free circulation of air, so as to keep the supporting metal cool.

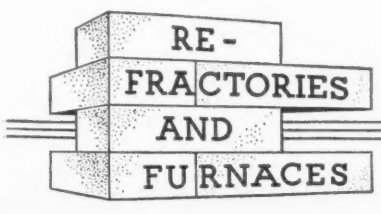
Greater Air Leakage

Because of the thinner construction of supported walls, greater leakage of air through them and into the furnace is likely to occur than with solid refractory walls. It is therefore important to have as few joints straight through the wall as possible to reduce air leakage to a minimum.

Both vertical and horizontal expansion must be provided for in suspended walls, whereas in solid walls vertical expansion is taken care of more or less automatically. In some walls, vertical expansion is taken care of by building the walls in separately supported panels with expansion joints between each section. In others, expansion is taken care of by the joints between each suspended tile. In such walls and in arches, fireclay should be used in the joints as its shrinkage when fired provides the space in the joints necessary for expansion. Horizontal expansion is provided for each individual tile in the same manner. Fireclay is used in the panel type of wall also because it makes repair easier, but cold-set high-temperature cements may be used if desired. In this case, joints for horizontal expansion must also be provided. High-temperature cement of course makes the wall somewhat more airtight.

It is sometimes desirable to use expensive special refractory in parts of the furnace subject to severe conditions, such as at the stoker grate line. Here silicon carbide is frequently used. On the next page are examples of construction designed for this purpose, which permit lining with 2 in. of silicon carbide, thus making a cheaper construction.

As mentioned in the first article, types of special insulating firebrick have been recently developed with a fusion temperature sufficiently high to withstand boiler furnace temperatures. They are used in supported walls as shown on the next page. The bricks are light, hence the supporting steel does not have to be as heavy as for fireclay refractory. Supported walls using insulating firebrick weigh between $\frac{1}{2}$ to $\frac{1}{3}$ the weight of an insulated wall with fireclay refractory face. Light weight makes it feasible to assemble the insulating brick on the casing panel and install both at one time by bolting the panel to the steelwork. Panels of this construction are applicable to the upper walls above the point at which slag may develop and where abrasion is not likely. The wall and arch constructions on the following pages are typical of present practice but do not show all of the types now available.



TYPICAL SUSPENDED WALLS

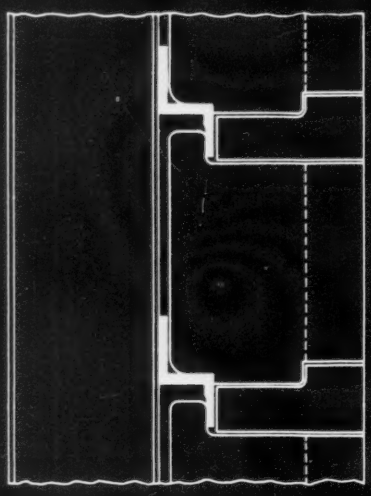


FIG.1- Bigelow-Liptak air-cooled, tile removed from furnace side

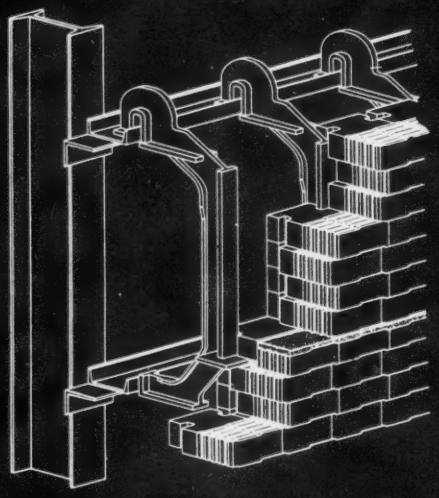


FIG.2- Detrick air-cooled, panel construction

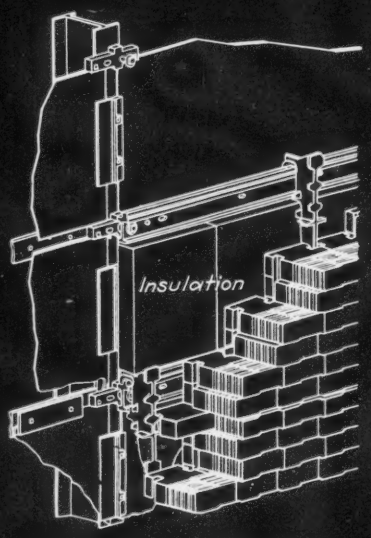


FIG.3- Detrick insulated wall

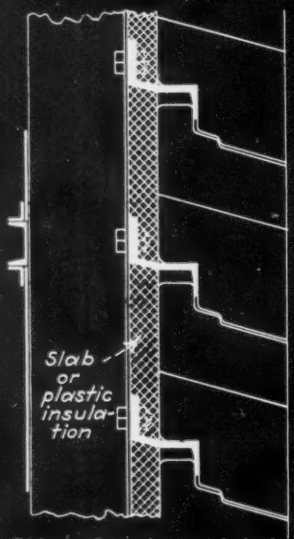


FIG.4- Bigelow-Liptak insulated wall tile removed from outside furnace

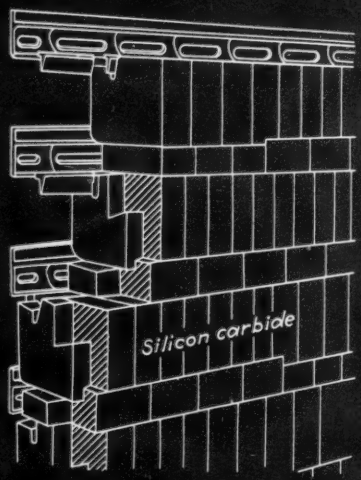


FIG.5- Bigelow-Liptak wall faced with silicon carbide

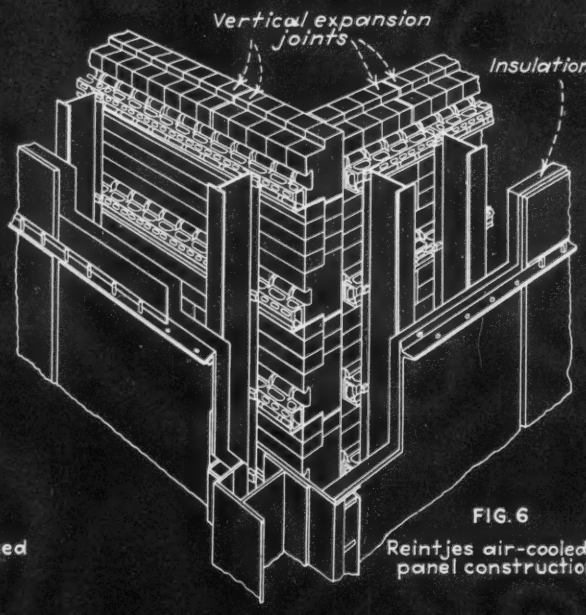


FIG.6
Reintjes air-cooled, panel construction

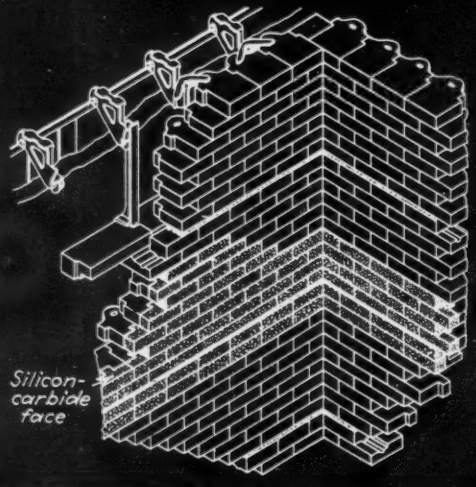


FIG.7
American arch air-cooled, panel construction with silicon-carbide face

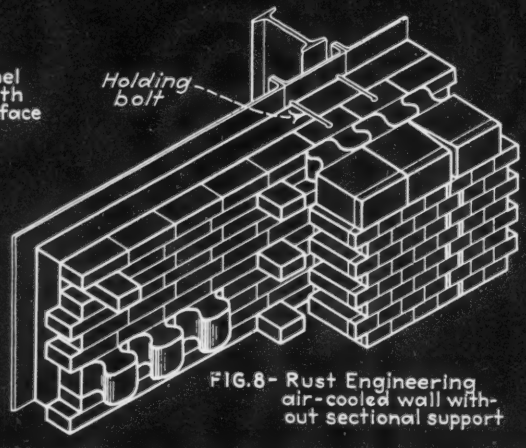


FIG.8- Rust Engineering air-cooled wall without sectional support

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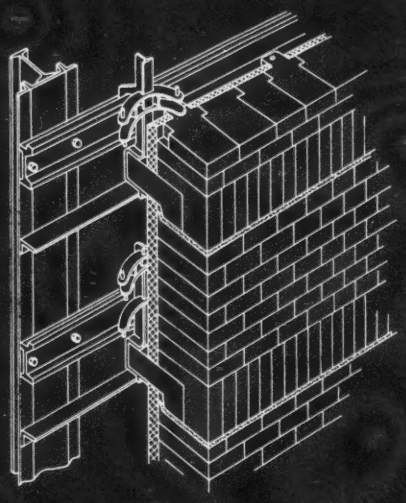


FIG. 9

American Arch insulated wall, panel construction

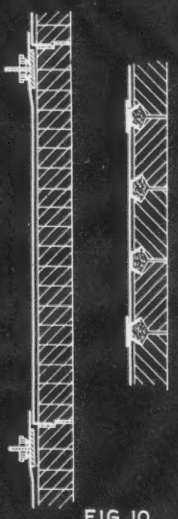


FIG. 10

Reintjes wall using insulating firebrick

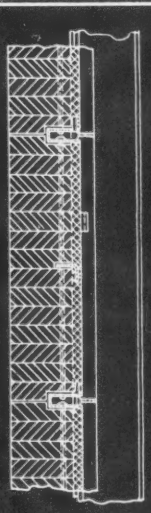


FIG. 11

Integral panel

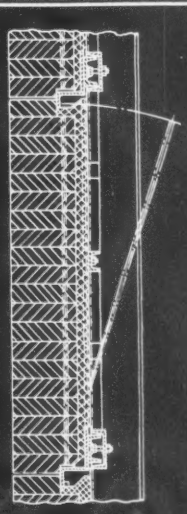


FIG. 12

Sectional panel

Babcox & Wilcox with insulating firebrick

TYPICAL SUSPENDED ARCHES

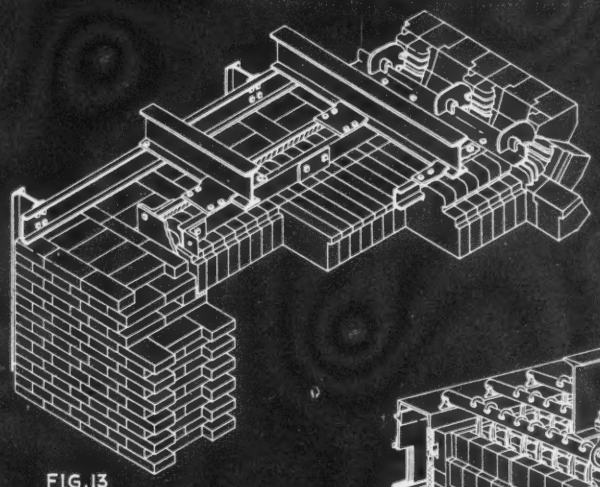


FIG. 13

American Arch, alternate rows of tile removable without disturbing channel suspension

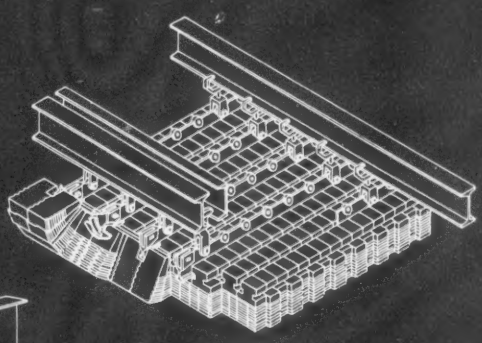


FIG. 14

Detrick tile corrugated on all sides prevent spalled refractory from falling into furnace

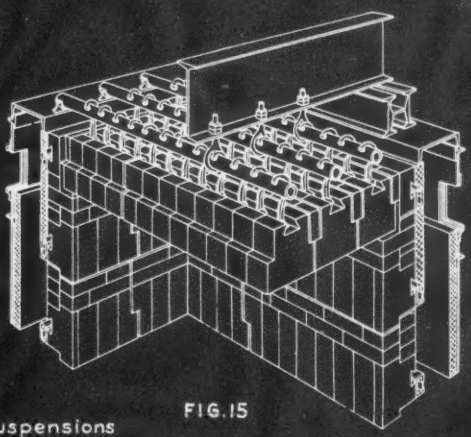


FIG. 15

Reintjes, each tile individually supported and removable

FIG. 17 - Mc Leod & Henry, each tile individually supported and removable

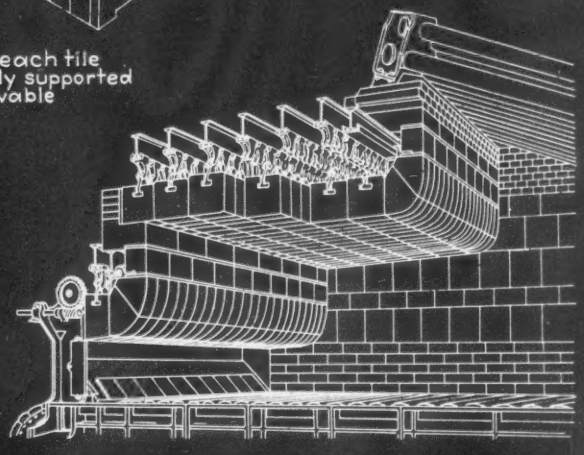
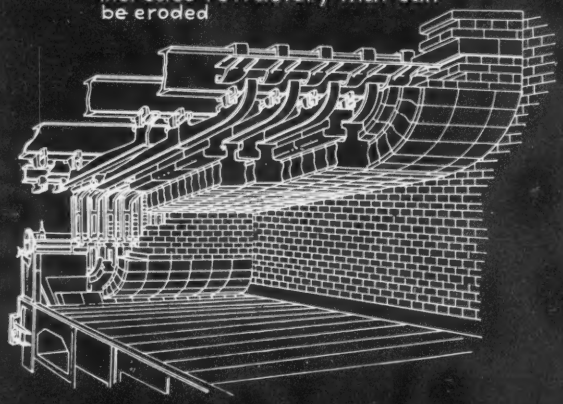


FIG. 16 - Bigelow-Liptak, double suspensions increase refractory that can be eroded



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WATER-COOLED WALLS

Practically all high-rating boiler installations made today have water-cooled walls. Typical examples of wall and slag-tap furnace bottom construction used with water cooling are here given

THE advent of water walls in boiler furnaces has considerably increased possible combustion rates and at the same time decreased furnace maintenance, thus increasing availability of boilers. In the article on furnace design, data are given showing to what extent water walls decrease furnace exit temperature. The water-wall surface is very effective heat-transfer surface which adds to the capacity of the boiler, or in other words decreases the surface necessary in the boiler proper for a given desired steam output.

Types of Walls

Today three types of walls are in use, bare-tube, refractory-coated tubes and tubes protected with cast-iron blocks. Tubes with bare cast-iron blocks are used along the fire line of chain-grate and underfeed stokers to protect the tube from abrasion by the coal and to provide a smooth plane surface to which clinker will not stick. They are also used to form the floor of slag-tap furnaces as in Fig. 10, and in the lower part of the walls of pulverized-coal furnaces where the flame comes close to the wall.

The cast-iron blocks are held on to the tubes by various mechanical means, as indicated in Figs. 3 and 4, and by casting the metal directly on the tube in such a way as to form a fused bond with the tube metal as in the detail of Fig. 1. When blocks are used on the upper part of water walls, they usually are made so a thin coating of ash will adhere to them or else have refractory embedded in the casting. A recent method of coating tubes with refractory is shown in Fig. 7. Studs are spotwelded to the tubes on the fire side, and the tubes and studs then covered with a plastic chrome refractory. The studs hold the refractory in place and also help to keep it cool.

Methods of Construction Changed

Walls made up of bare tubes backed with firebrick or insulating refractory are used in all parts of the furnace except at the fire line and ash pit where protection is usually provided. Some bare-wall tubes have fins welded to them to seal the space between the tubes and present a full metal surface to the furnace.

Water walls have completely changed methods of furnace-wall construction. Where the tubes are protected with block or provided with fins, no refractory is used. Back of the tubes, a plastic insulation is usually used to fill in irregularities and to make a plane surface against which block magnesia, rock wool or diatomaceous earth insulation can be placed. Insulation is usually wired so it will stay in place until the steel casing can be erected, the casing later being the main means of holding the insulation.

When bare tubes without fins are used, they are backed with fireclay refractory followed by insulation. The refractory may be special tile shaped to the curvature of the tubes so that the refractory fills in between them, as in Fig. 5, or it may be shiplap tile as in Fig. 2. When refractory and block insulation is used, the distance allowed between the water-wall tubes and the casing should be greater than that actually required by the refractory and insulation, to allow for variation in the location of the tubes and dimensions of the insulation and refractory.

Good circulation in water walls is exceedingly important to their satisfactory performance and low maintenance. It is strictly a problem for the boiler manufacturer and hence is not here discussed. Another problem in water walls is the provision for suitable observation and access doors. Whether tubes are bent or subheaders used depends upon the size of the opening, type of wall and local conditions of space.

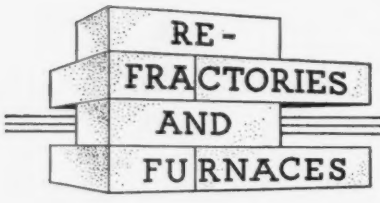
Slag-Tap Bottoms

When slag-tap furnaces were first used, various kinds of refractory materials were tried for the furnace bottom. In these first installations, there was a tendency for the bottom, in expanding, to push the walls out. Also, the refractory sometimes floated out with the fluid ash. With the adoption of air or water cooling, these troubles have been largely overcome.

Fig. 11 is an example of an air-cooled bottom for a slag-tap furnace. The refractory blocks, which are laid in two courses, are shaped like truncated pyramids with slightly curved bases. When expansion occurs, the shape of the blocks causes them to slide relative to each other and raise the bottom slightly instead of pushing against the furnace walls. The refractory blocks are covered with a layer of plastic chrome, and in addition a layer of crushed slag when the furnace is first started. Passages for cooling air are formed by refractory tile.

Two types of water-cooled bottoms are shown in Figs. 8, 9 and 10. In one the tubes are covered with cast-iron block. Joints between blocks come at the tube center lines, so preventing slag leakage. The tubes are backed with plastic insulation and block insulation.

The other type of water-cooled bottom employs finned tubes. They are either covered over to a depth of several inches with plastic chrome refractory, or filled in between with fireclay. When fireclay is used, a refractory tile is placed between the tubes and below the joint between adjoining fins. The fireclay or chrome is usually covered with stoker slag for initial operation. Bottoms are insulated with Rockwool.



TYPICAL WATER WALLS

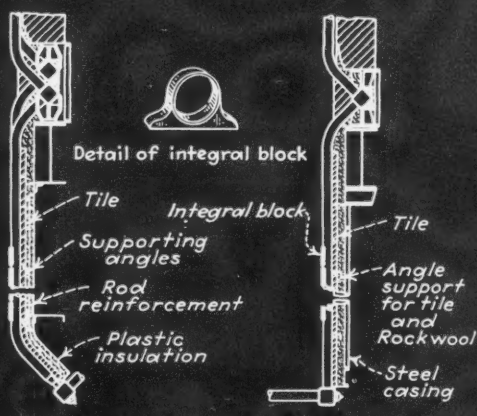


FIG. 1 – Combustion walls with plastic insulation and detail of integral cast-iron block

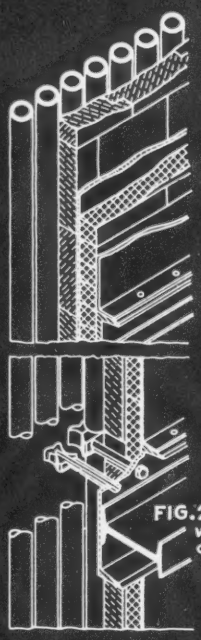


FIG. 2 – Riley wall with insulation and steel casing

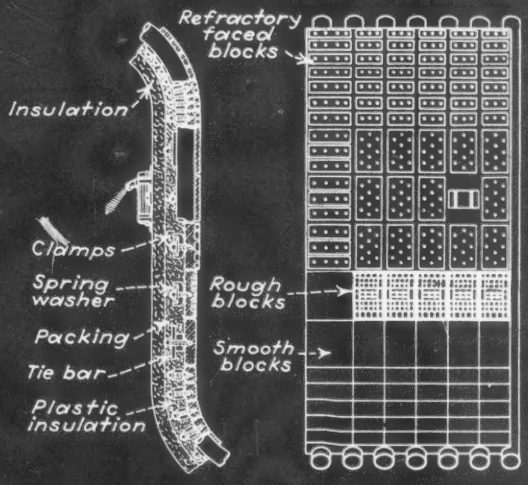


FIG. 3 – Babcock & Wilcox walls with smooth, rough and refractory-faced blocks

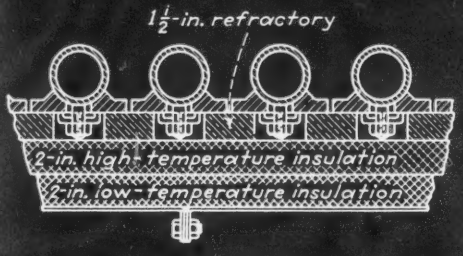


FIG. 4 – Foster Wheeler armored wall and insulated steel casing

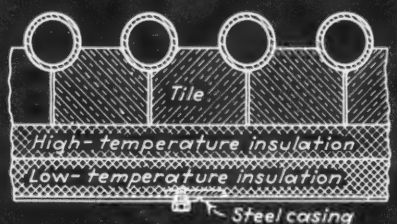


FIG. 5 – Foster Wheeler bare tubes with refractory backing

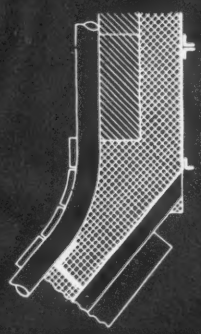


FIG. 6 – Edge Moor wall, bare tubes with cast-iron blocks

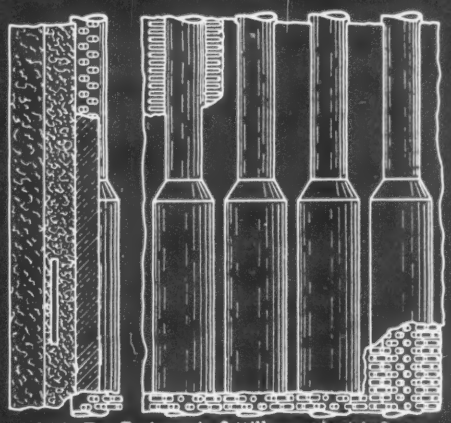


FIG. 7 – Babcock & Wilcox stud tubes covered with plastic refractory

SLAG-TAP FURNACE BOTTOMS

FIG. 8 – Combustion using fin tubes backed with refractory tile

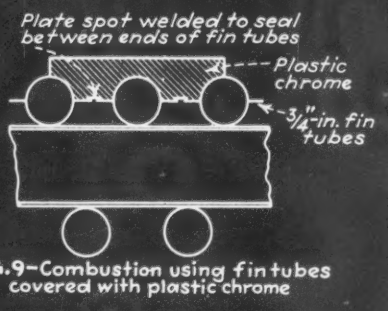


FIG. 9 – Combustion using fin tubes covered with plastic chrome

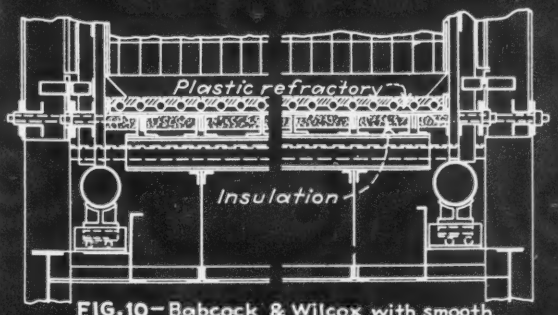


FIG. 10 – Babcock & Wilcox with smooth cast-iron block

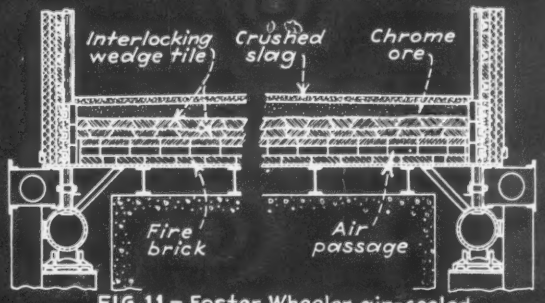


FIG. 11 – Foster Wheeler air-cooled refractory bottom

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WHAT GOVERNS FURNACE SIZE?

A determining factor is rate of heat liberation per square foot of cooled surface exposed to furnace radiation

SIZE, shape, and construction of boiler furnaces depend upon many factors, some local in character, some governed by the judgment and combustion experience of the designer. Each boiler furnace is tailor-made to fit conditions. It is not surprising, then, that no two boiler plants have similar furnaces.

Furnace design is affected by the economic factors of cost, duration or hours of operation, cost of fuel, duration of peak load, and duration of minimum load; by combustion factors of efficiency, kind and character of fuel, method of firing, magnitude of peak and minimum loads; and by physical factors of space available and type of boiler. The economic end sought is minimum cost consistent with operating conditions and with life of furnace and cost of maintenance. For example, an expensive water-cooled furnace is not generally justified for a boiler operated only during the heating season and then at light loads for most of the time. In most cases it would not be good economics to design a furnace for continuous operation at maximum peak load when peak is short and seldom occurs.

Many decisions must be made before furnace design can be started. Important among these are peak load and maximum load to be carried continuously, kind of fuel, type and character of fuel-burning equipment, and dimensions of the boiler. The furnace should be capable of sustaining the maximum continuous combustion rate with the desired excess air without slagging the furnace walls, bottom or boiler tubes. Experience indicates this can be accomplished by designing the furnace so that the ash particles entering the boiler are not above their fusion temperature.

Furnace volume, heat release, excess air, water-cooled surface exposed to furnace radiation and fusion temperature of the ash are the factors in determining furnace exit temperature. Exit furnace temperature does not depend entirely upon heat release per cubic foot of furnace volume, nevertheless it is common practice to limit the heat released per cubic foot to approximate values depending on firing method, type of furnace and kind of fuel. Recommended heat values for various conditions are:

	All-refractory Furnace	Complete Water-wall Furnace
	Heat Release, B.t.u. per cu.ft.	
Pulverized Coal 15% CO_2 at Furnace exit, Illinois Coal	12,000–15,000	20,000–35,000
Eastern Bituminous Coal	20,000–22,000	25,000–35,000
Underfeed Stoker	25,000–35,000	30,000–42,000
Chain or traveling grate stoker	15,000–25,000	30,000–45,000
Oil	20,000–30,000	30,000–50,000

Heat release per square foot of cold surface exposed to the furnace is a ratio used in determining furnace exit temperature. Curves such as in Fig. 1 use this ratio together with excess air, as indicated by CO_2 to find exit temperature, and are very helpful in furnace design. For example, suppose it is desired to obtain 140,000 lb. of steam an hour from a boiler 21 ft. wide with straight tubes 24 ft. long, and that a coal having an ash fusion temperature of 2,100 deg. is to be burned. If an efficiency of 75% is desired at full load, the heat released in the furnace will be about 194,000,000 B.t.u. per hr. With an all-refractory furnace the cold surface exposed is 21 x 24 = 504 sq.ft., and the heat release per sq.ft. of cold surface is 385,000 B.t.u. per hr. For satisfactory continuous operation with this coal the exit temperature should not be above 2,100 deg. Hence from Fig. 1 it is evident that not over 10% CO_2 should be carried at full load if refractory difficulties are to be avoided. This is not good operation and would not yield the efficiency desired. If, however, enough water-wall surface is installed in the furnace to bring the heat released per square foot of cold surface down to 115,000 B.t.u., full load can be carried with 13% CO_2 without trouble from ash fusion, and the 75% efficiency should be reached. With pulverized-coal firing, the furnace volume necessary with water walls would be 194,000,000 divided by say 20,000 B.t.u. per cu.ft., or 9700 cu.ft., which would require this furnace to be 19 ft. 3 in. high, assuming the walls are vertical.

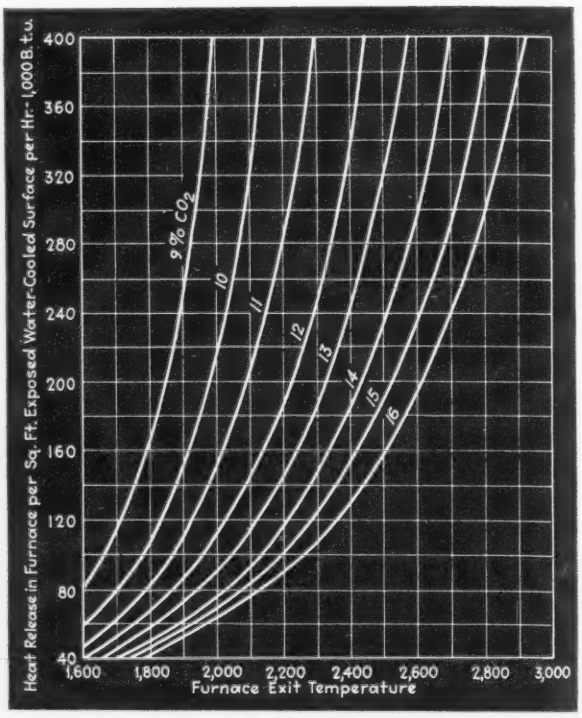


Fig. 1—Estimating furnace exit temperature is important in furnace design

RE-FRACTORIES AND FURNACES

To reduce the heat release to 115,000 B.t.u. would require side and rear water walls. By adding water walls to the front wall the excess air could be further reduced and the efficiency improved or output increased. Whether this should be done depends upon whether or not the improved efficiency, together with fuel cost and operating time, will justify the additional fixed charges on the increased cost of the front wall. On the other hand, if full load will be of short duration it is good practice to design for somewhat higher exit temperatures. Further to indicate the possible variations, the same load could be carried with high efficiency in an all refractory furnace if a better grade of coal were used having an ash fusion temperature not less than 2,600 deg. To look at it another way, water walls increase the capacity of a given boiler.

Shape of the furnace depends upon the boiler and the equipment used for firing. Width of the furnace is always practically the same as width of the boiler. Depth, however, depends upon other considerations. In the case of bent-tube boilers the depth is seldom less than the projected distance between the mud drum and the front steam drum, but it may be, and often is, more than this, particularly when height of the furnace is limited by local conditions. For straight-tube boilers, depth at the furnace exit is never more than the depth of the boiler, but may be less, as is the case when a bridge or rear-arch wall is used.

Fig. 2—Furnace arranged for burning bituminous coal on chain-grate stoker

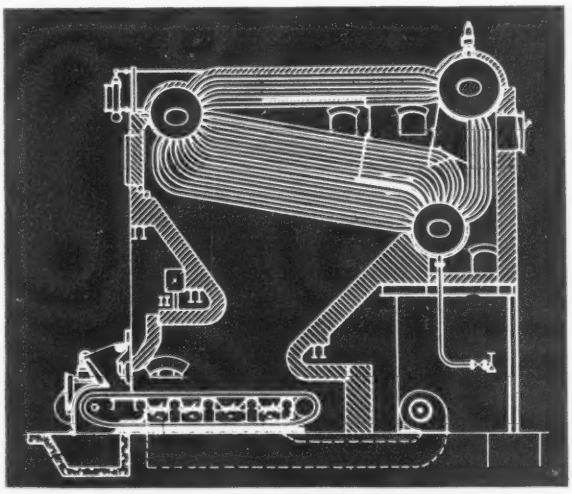
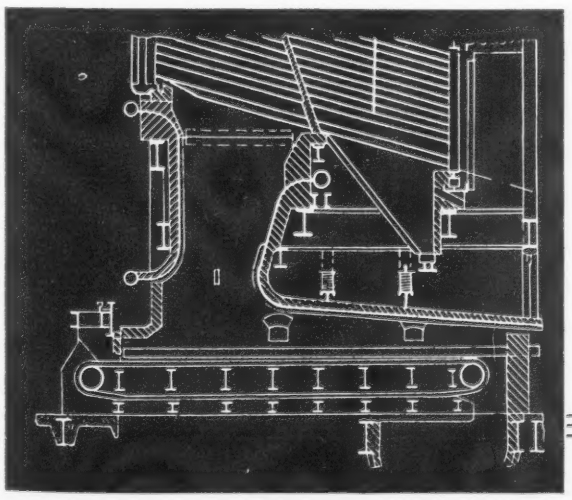


Fig. 3—Furnace with water-cooled arches arranged for burning anthracite coal on chain-grate stoker.



For pulverized coal, underfeed stokers, oil and gas firing the tendency is to use vertical walls as much as possible. Sometimes in stokered installations it is necessary to slant the rear wall to meet the stoker dimensions.

When the wall is water cooled, no difficulty is likely to result, and it will not be much more expensive to build. Where refractory walls are involved, suspended construction should be used, and even then erosion troubles may be encountered.

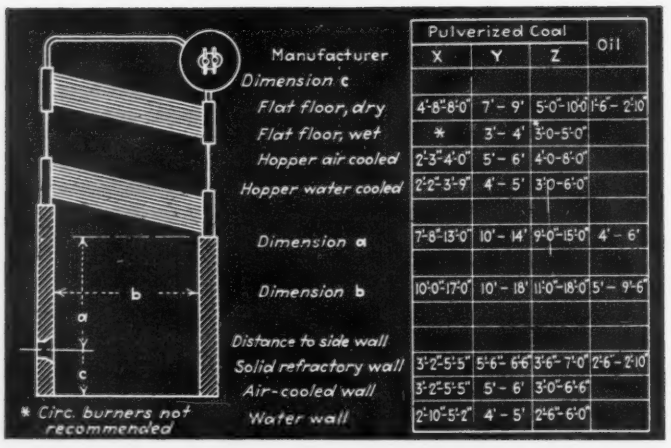
Pulverized-coal Firing

With pulverized-coal firing, shape is influenced by direction of firing and method of ash removal. When horizontal firing is employed, two dimensions fix the minimum height of furnace—the minimum distance from center line of burner to the furnace floor or start of ash hopper, and the minimum distance from burner center-line to the boiler tubes. The latter dimensions must be maintained if smokeless and complete combustion is to be obtained and trouble from slag on the boiler tubes avoided. These dimensions vary with the capacity of the burner and are as shown in the table for different makes of burner. The table also gives minimum dimensions for oil firing. Except that higher heat release rates are permissible because of the absence of ash, oil or gas furnaces are similar in shape to furnaces fired horizontally with pulverized fuel. In the case of oil or gas, the furnace floor is always flat and usually air cooled. With pulverized fuel, hopper bottoms are usually used only for larger installations, or when head room is available.

Slag-tap bottoms further influence design of pulverized-coal furnaces. Difference of opinion exists concerning the conditions favorable to the use of this method of ash disposal. Some recommend it only when the fusion temperature of the ash is not over 2,250 to 2,300 deg., while others claim successful operation is possible with coals having ash fusion temperatures as high as 2,500 to 2,600 deg. Duration of high and low loads are other factors affecting its use. When used, some manufacturers prefer to arrange the burners either for vertical or inclined firing. Both vertical and horizontal burners are placed closer to the floor than would be the case with a dry bottom.

In general, furnace heights are less for underfeed stokers than for pulverized fuel. For high-rating large-capacity installations, 15 to 20 ft. should be allowed from the floor line to the boiler header in the case of straight-tube boilers, and 10 to 14 ft. to the mud-drum center line in the case of bent-tube boilers. For small low-rating installations, setting height should not be less than about 8 ft. for straight-tube boilers and 6 ft. for bent-tube boilers.

When water cooling is applied to underfeed stokered furnaces the bridge wall or rear wall should be the first wall cooled. The next furnace cooling surface added should be in the side walls along the fuel line. Water wall tubes at this point should be protected by cast iron or refractory blocks, both to



Manufacturer	Pulverized Coal X	Pulverized Coal Y	Pulverized Coal Z	Oil
Dimension c				
Flat floor, dry	4'-8"-8'-0"	7' – 9'	5'-0"-10'-0"	1'-6" – 2'-10"
Flat floor, wet	*	3' – 4'	3'-0-5'-0"	
Hopper air cooled	2'-3"-4'-0"	5' – 6'	4'-0-8'-0"	
Hopper water cooled	2'-2"-3'-9"	4' – 5'	3'0-6'-0"	
Dimension a	7'-8"-13'-0"	10' – 14'	9'-0"-15'-0"	4' – 6'
Dimension b	10'-0"-17'-0"	10' – 18'	11'-0"-18'-0"	5' – 9'-6"
Distance to side wall				
Solid refractory wall	3'-2"-5'-5"	5'-6" – 6'-6"	3'-6" – 7'-0"	2'-6" – 2'-10"
Air-cooled wall	3'-2"-5'-5"	5' – 6'	3'-0"-6'-6"	
Water wall	2'-10"-5'-2"	4' – 5'	2'-6"-6'-0"	

Fig. 4 — Minimum dimensions for locating circular pulverized-coal and oil burners of low and high capacity

prevent abrasion of the tubes and to provide a smooth surface to which clinker will not stick. Such side walls are usually inclined tubes parallel with the stoker and carried up about 7 tubes high. When vertical tubes are used, the entire wall is usually water cooled and should include the ashpit. Inclined tubes sometimes make it impossible to locate the access door in the most desirable place, whereas vertical tubes do not impose this limitation. The front wall is seldom water cooled, because the temperatures there are not so high, and in the case of straight tube boilers the wall is not very high.

Because chain or traveling grates require arches, furnaces for them differ radically from furnaces designed for other firing equipment. Likewise, as there exists a great difference of opinion concerning the proper location and shape of these arches, the resulting variations in furnaces are almost endless.

One of the main purposes of arches as used in early installations was to assist in igniting the coal by directing radiant heat from the arch to the green coal as it entered the furnace. Today there is a considerable tendency away from this practice, and arches are designed to function quite differently and for other purposes. Among other functions, arches are arranged to create turbulence, seal and protect the rear of the stoker, protect the gate, and assist ignition by directing particles of burning coal so they will fall on entering green coal.

Water Cooling

Another important trend that should be mentioned before further discussion of arch location is the use of water cooling for arches and side walls along the fire line. Water-cooled arches permit higher ratings and placing the arch somewhat closer to the fire. Ratings of over 400% have been made possible by installing water-cooled arches. Water-cooled side walls with cast-iron block on the tube surface has decreased the maintenance of refractory along the fire line and decreased disturbance of the fuel bed caused by clinker sticking to side walls. Water cooling is apparently causing an increase in use of this type of stoker.

For chain-grate furnaces in which anthracite, coke breeze or lignite is to be burned, there is a general trend toward greatly reducing the size of the front arch. A recent furnace for anthracite is shown in Fig. 3. A very short front arch is shown; its main purpose being to protect the stoker gate. The long rear arch serves several functions. At the rear end it is placed close to the grate, 9-10 in., so as to seal against air entering the furnace from the ash pit. Any air that may enter the furnace at this point is directed by the arch toward the front of the stoker where it will mix with and help burn the richer gas. It further shades the rear part of the stoker from radiation from other refractory.

The arch is quite close to the stoker throughout its length and so produces a horizontal gas velocity of about 20-30 ft. per sec. Burning particles of coal that lift off the grate are carried forward by the high velocity gas and deposit on the front of the stoker where they aid in igniting the green coal. The arch in Fig. 3 was carried far enough forward to produce a velocity of about 45 ft. per sec. at the furnace throat. Height of boiler above the grate may limit the distance the arch can be carried forward as care should be taken not to form a pocket between the arch and the first row of boiler tubes where soot may build up.

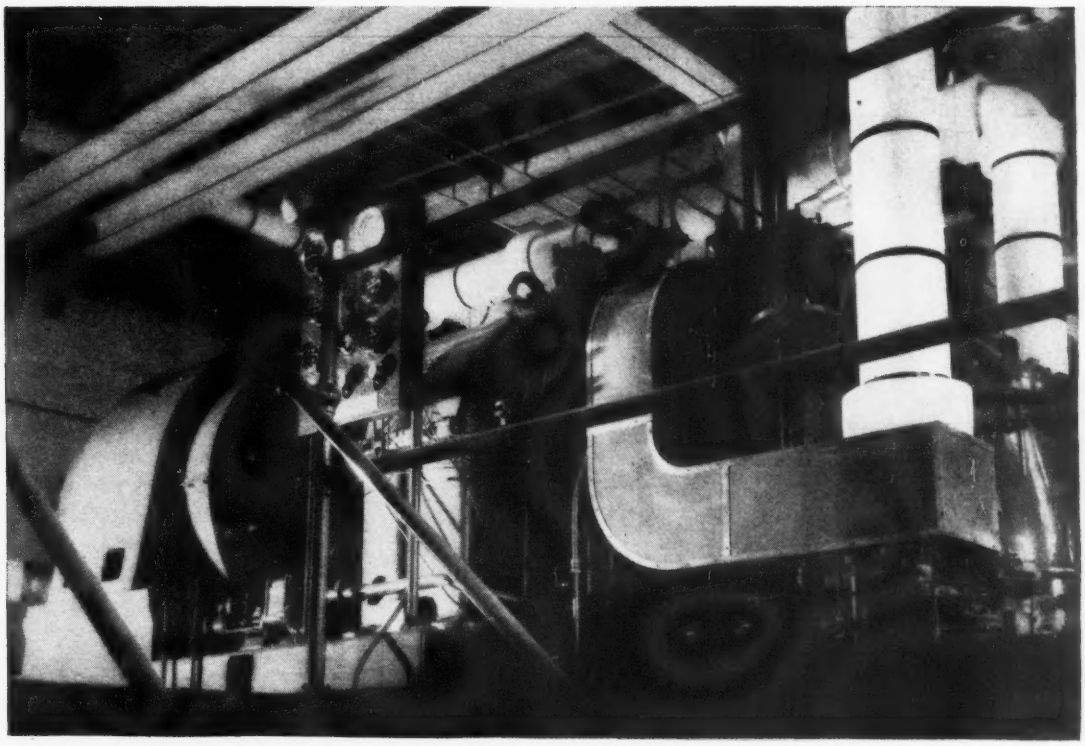
Front Arches

Front arches, however, are still used when bituminous coal is fired. They are usually placed 4½ to 5 ft. above the stoker. The distance they extend out over the stoker depends largely upon local conditions of setting height, length of stoker and how it is placed with respect to the boiler. When the main arch is set at this height a short ignition and gate-protecing arch is usually installed under it, set 18-24 in. above the grate and 12-18 in. long. The purpose of the main arch is to throw the rich gas from the front of the stoker to the rear where it can mix with the leaner and hotter gases from the rear of the stoker and so be completely burned.

With bituminous coal, overfire air is almost always necessary for smokeless combustion. It should be admitted to the furnace under the front main arch and generally not closer to the grate than 4 to 4½ ft. Overfire air supply should be taken from the main air duct ahead of the control damper to insure ample pressure when the damper is partially closed during low loads.

The rear arch for bituminous coal firing is much shorter than that used with anthracite. It need only be long enough to protect the rear of the stoker and for a seal against air from the ashpit. Consequently it is usually placed quite close to the grate.

Arch arrangements for burning low grade fuels should be made to fit each case and are too specialized to be covered in this article. Many times local conditions such as location of building or other supporting steel and available heights makes it necessary to change furnace shape and size from what would be considered the ideal. It then becomes the engineer's problem to compromise the variables so as to obtain the best job under the circumstances.



EFFICIENT FLEXIBLE RELIABLE

Moderate in size, Byron Weston Company's new 415-lb. boiler provides 24-hr. service either to new 1,437-kw. bleeder turbine or old 150-lb. units. Old low-pressure boilers can serve new turbine

BYRON Weston Company, maker of fine ledger and bond papers, has recently installed a new steam and power plant to operate its mills at Dalton, Mass.

Generating steam at 415 lb. pressure, and employing a bleeder-type turbine, the plant has demonstrated the remarkably high efficiencies possible today in moderate-sized industrial units. It replaces a steam plant operated at 150 lb. pressure and supplemented by purchased power. The old turbine and all but two old boilers are maintained as reserve units.

The mills operate 24 hours a day, and sustain a heavy loss from any interruption to the essential power load which drives the paper machines. To insure continuous operation without the expense of duplicating the new boiler and turbine, the turbine was designed to carry full rating with 150-lb. steam from the old boilers. The old turbine may be operated from the new boiler through a pressure-reducing valve and desuperheater. All boiler and turbine auxiliaries are in duplicate, one motor driven and one steam driven.

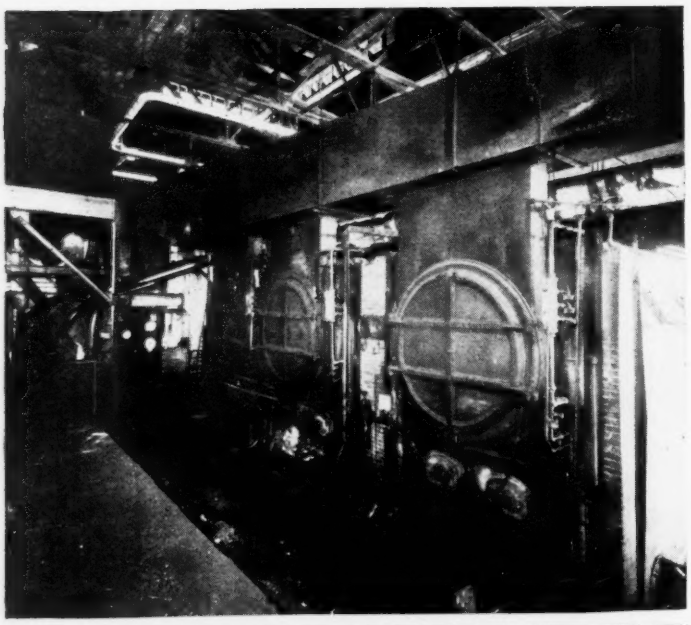
Weekend load is carried by a back-pressure house turbine driving a.c. and d.c. generators. This turbine, like the main unit, is designed and piped for operation from either the new or the old boilers, and so permits shutting down the new boiler for weekend cleaning.

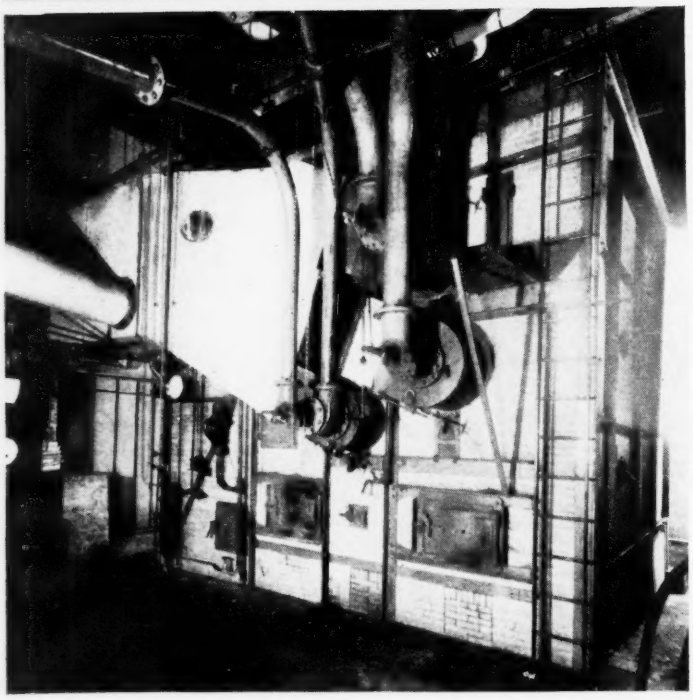
The plant was installed in the existing power house without changes to walls or roofs, except for a small penthouse enclosing the upper end of the new coal elevator. As height under the trusses was sufficient for the type of boiler selected, space was obtained by removing two old HRT units. Turbines were installed in an existing building adjacent to the boiler house.

With a rated capacity of 35,000 lb. per hour, the boiler generates at 415 lb. and 625 deg. It has two drums, with inclined tube bank. On one side of the tube bank is the combustion chamber, enclosed with water-cooled walls on all sides except the front or burner wall. Tubes under the furnace floor are covered with cast-iron blocks.

The boiler is fired by two ball-type pulverizers, each having a rated capacity of 3,350 lb. of coal per hour. Under normal conditions, each pulverizer will develop full boiler rating. The second pulverizer is used when excessive moisture in the coal reduces pulverizer capacity, when peak loads between 35,000 and 40,000 lb. are carried, or when a reserve unit is required. One pulverizer is driven by turbine, the other by motor.

Each pulverizer has its own main burner of sufficient





THE OLD AND THE NEW

Top—Three of the old 150-lb., hand-fired HRT boilers. Below—The new 35,000-lb. per hr., 415-lb. pressure, 625-deg. temperature pulverized-coal-fired boiler.

size for full capacity. For weekend operation, when load falls to 3,500 lb. of steam per hour, a small double burner, supplied from either pulverizer, is used. Primary air, taken from the outlet of the air preheater, is tempered with air at room temperature and supplied to the pulverizers under pressure. Each pulverizer has its own primary air fan.

A forced-draft fan supplies air at 450 deg. for combustion through an air preheater which reduces flue-gas temperature to 360 deg. For steam loads under 15,000 lb. per hour the boiler operates on natural draft; for higher loads an induced-draft fan is used.

Boiler operation is manually controlled and guided by a steam-air flow meter. Coal supply rate is regulated by hand-operated gates on pulverizer feeds. Primary air is controlled by dampers on fan inlets.

Forced draft is governed by a 2-speed motor driving the fan and by a motor-driven vane mechanism in the fan inlet. Induced draft is controlled by a variable-speed motor driving the induced-draft fan. All fan controls are at the boiler-operating panel.

A system of electrical interlocks controls the motors driving the forced- and induced-draft fans and the pulverizers to prevent accumulation of pulverized fuel in the boiler and air preheater. These are arranged so that if either the forced- or induced-draft fan motors stop because of current failure, the two pulverizers are stopped. If the induced-draft fan motor stops because of current failure, the forced-draft fan stops.

Coal is stored in an existing concrete bunker next to the boiler house. A new coal conveyor was installed under the bunker and arranged to deliver into a new cylindrical steel live-storage tank over the pulverizers. It holds about a 12-hr. supply. Coal is automatically weighed between live storage and pulverizer feeders.

Main Turbine

The main turbine, rated for 1,437-kw. continuous load, operates with steam at 400 lb. and 625 deg., and is a 6-stage impulse-type machine with extraction between the first and second stages. A governor-operated external bleeder valve may be adjusted to vary bled-steam pressure from 8 to 12 lb. The turbine exhausts to a surface condenser. Vacuum maintained is 29.3 referred to a 30-in. barometer reading. Condensing water flows by gravity from a waterwheel flume. In addition, 900 g.p.m. of cold artesian well water is pumped through the lower part of the condenser and is then used in prcoesses. In this way higher vacuums are attained than river-water temperature would permit.

The turbine runs at 6,000 r.p.m. and drives the generator through single-reduction helical gears of 2,000-hp. capacity. The generator, with its direct-connected exciter, runs at 1,200 r.p.m. without forced ventilation.

A gravity oil system for turbine and gears supplements the geared oil pump and oil reservoir in the turbine base. This includes a 200-gal. oil tank elevated to give 6 lb. oil pressure at the turbine. Oil, through a relief valve in the discharge from the geared pump, circulates into the storage tank from which it flows by gravity to the turbine and gears. A centrifugal oil purifier operates on a bypass for continuous purifying.

Bled steam, averaging 60% of the total steam generated, is used in the various manufacturing processes, and returns to the power plant. It is not used for boiler feed, however; as existing piping system for process steam has accumulated oil from the exhaust of a reciprocating engine formerly used, and the bled steam return has an appreciable oil content. Therefore, raw water makeup is comparatively high, amounting to 60 or 70% of boiler feed. This makeup flows in a thin sheet over a baffle plate extending the full length of the condenser.

A small bled steam connection maintains temperature in the hot well at a point where deaeration is accomplished. Air from the condensate and from makeup water is removed from the condenser by a 2-stage steam-

ejector vacuum pump combined with an inter-and-after surface condenser. Careful chemical tests have repeatedly indicated that oxygen in the deaerated water is less than 0.4 parts per million.

From the hot-well pump, the deaerated mixture of condensate and makeup passes through a heat exchanger where heat in the oily mill returns is extracted, and then to a 1,500-gal. cylindrical feedwater receiver above the boiler feed pumps. A float in the receiver controls the amount of makeup water fed to the condenser. Bled steam fills the space in the receiver above the water, thereby preventing the water from absorbing oxygen from the air. From the receiver, water flows to the boiler feed pumps by gravity, aided by the pressure of the steam blanket in the upper part of the receiver.

NEW POWER PLANT EQUIPMENT

Byron Weston Co., Dalton, Mass.

Boiler Room Equipment

Boiler, integral furnace type, 35,000 lb. per hr., 450 lb. design pressure, heating surface 4,313 sq.ft. Babcock & Wilcox Co.
Superheater, inverted U-tube, 3 loops, 35,000 lb. per hr. capacity, 625 deg. total temperature..... Babcock & Wilcox Co.
Furnace, integral, water-cooled, 1,570 cu.ft., Bailey block covered floor Burners, two 8 in. diam., one double 5 in. diam. .....Babcock & Wilcox Co.
Pulverizers, two, one driven by General Electric 30-hp. motor, other by DeLaval geared steam turbine .....Babcock & Wilcox Co.
Air preheater, 4,116 sq.ft. heating surface Thermix plate type .....Prat-Daniel Corp.
Forced-draft fan with vane control, driven by Reliance 15-hp., 2-speed motor operated by remote control, B. F. Sturtevant Co.
Induced-draft fan, driven by Reliance 30-hp. wound-rotor motor .....B. F. Sturtevant Co.
Soot blowers .....Diamond Power Specialty Corp.
Automatic coal scale .....Richardson Scale Co.
Boiler feed pumps, two 4-stage centrifugal, 3,600 r.p.m. capacity 90 g.p.m. against 500 lb. pressure, driven by 60-hp. Crocker-Wheeler motor and DeLaval geared steam turbine with excess pressure and constant-speed governor.....DeLaval Steam Turbine Co.
Feedwater heater, 4-pass, closed type..Griscom-Russell Co.
Feedwater regulator & excess pressure control, Copes Northern Euipment Co.
Main turbine, geared .....DeLaval Steam Turbine Co.
Generator; direct-connected exciter, 1,563 kva. capacity with 40 deg. C. rise, 1,200 r.p.m., 400 lb. steam pressure, 625 deg. F. steam temperature at throttle, bled steam at 10 lb. gage from 10-in. diam. connection, current characteristics: 600-volts, 3-phase, 60-cycle .....Electric Machinery Mfg. Co.
Condenser, surface type, 1,610 sq.ft. tube surface C. H. Wheeler Mfg. Co.
Vacuum pump, 2-stage steam-jet air pump with inter-and-after condenser.....C. H. Wheeler Mfg. Co.
Condensate pump, driven by Crocker Wheeler 7½-hp. motor .....C. H. Wheeler Mfg. Co.
Reserve condensate removal unit, 4-in. condensate removal unit, 4-in. condensate ejector..... Schutte & Koerting Co.
House turbine, geared, back-pressure type..DeLaval Steam Turbine Co.
Generator, 250-kw., 600-volt, 3-phase, 60-cycle....Electric Machinery Mfg. Co.
Generator, 75-kw, 125-volt, d.c.....Reliance Electric & Engrg. Co.
Clutch, Diamond D cut-off coupling.....Dodge Mfg. Corp.
Switchboard .....Westinghouse Electric & Mfg. Co.
Thermo-compressors .....Schutte & Koerting Co.
Control for thermo-compressors..... Mason-Neilan Regulator Co.
Pressure reducing valve & desuperheater ...Swartwout Co.
Boiler safety valves ....Consolidated Ashcroft Hancock Co.
Boiler non-return valve and stop and check valve..Edward Valve & Mfg. Co.
Boiler blow-off valve .....Yarnall-Waring Co.
Steam & water valves, high & low pressure..... Lunkenheimer Co.
Relief valves .....Atwood & Morrill Co.
Traps .....Armstrong Machine Works
Boiler meter .....Bailey Meter Co.
Boiler, superheater, air preheater, pulverizer....Babcock & Wilcox Co.
Turbine generator, condenser, pumps, feed-water heaters & receiver, heat exchangers....Turbine Equipment Co. of New England
Boiler setting .....Frank E. Ross Co.
Piping .....Lumsden & Van Stone Co.
Pipe covering .....Philip Carey Co.
Breeching & flues .....Jennison Co.
Switchboard & wiring .....Westinghouse Elec. & Mfg. Co.
Foundation .....By the owners
Feedwater treatment .....Hall Laboratories
Protective treatment .....Dampney Co. of America

As the temperature of the water in the receiver is only 135 deg., and as the combined positive pressure on the suction of the pumps is equivalent to a 25-ft. head, ideal conditions for positive feed to the pumps are assured. The pumps discharge to the boiler through a closed feed-water heater, using bled steam for heating.

A certain amount of steam at 60 lb. pressure is also required for process. Demand varies from about 1,800 lb. per hour to 8,000 lb. Minimum demand is supplied by the turbine driving one pulverizer.

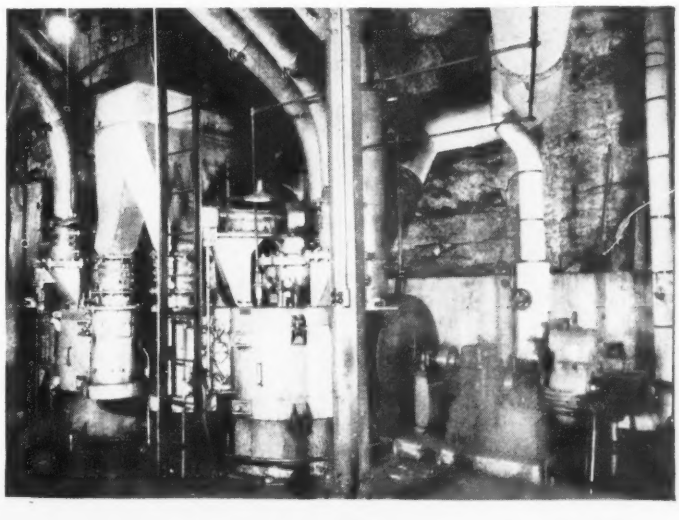
Two thermo-compressors furnish 3,000 lb. more of 60 lb. steam. Using boiler steam at 415 lb., they compress bled steam from 10 to 60 lb. Each compressor is cut in or out automatically according to the pressure in the 60-lb. line. 60-lb. steam in excess of that supplied by the pulverizer turbine and thermo-compressor is furnished through the main pressure-reducing valve. This valve with its desuperheater fulfills two functions. Normally it is set to maintain 60 lb. on the low-pressure side. It may be quickly adjusted, however, for 150-lb. low pressure and would be used when so adjusted for supplying 150-lb. steam to run the old turbine, in case the new turbine had to be taken off the line. Under this condition, 150-lb. steam would be used for process in place of 60-lb. steam. A second pressure-reducing valve, working between 150 lb. (or 60 lb.) and 10 lb. insures the supply of low-pressure process steam against a deficiency of bled steam.

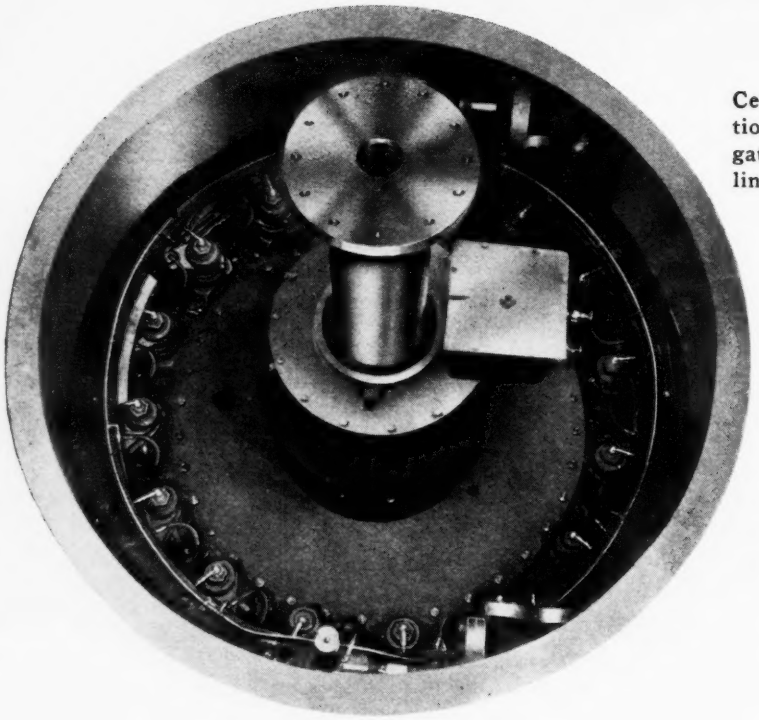
The 325-kw. house turbine drives a 250-kw. a.c. generator and a 75-kw. d.c. The generators are coupled together and connected to the turbine through a clutch. During the week, this clutch is disengaged, and the electrical end operates as a motor-generator set to produce direct current. With the clutch engaged, the unit serves not only for weekend power requirements, but is available as a reserve generating unit.

The plant has been in operation over seven months, during which time steam load has varied from 18,000 to 40,000 lb. per hour, and power load from 450 to 1,400 kw. The combined efficiency of boiler, superheater and air preheater, as indicated by the automatic coal scale and steam flow meter, has held between 80 and 84% over this widely varying load. Savings will pay for the new plant in less than four years.

The plant was designed and constructed under the supervision of Henry H. Fales, consulting engineer, Providence, R. I.

Two ball-type pulverizers, showing the geared steam turbine which drives one





Centralized grease lubrication system applied to gate stem bearings and links and pins in a hydro turbine

GREASES—

WHERE . . . HOW

Grease versus oil lubrication. Advantages and disadvantages of various methods for applying grease to bearings. An extension of the article "Greases" in the August number of *Power*

By James I. Clower

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OBVIOUSLY, no hard and fast rule can be laid down as to when a grease is preferable to an oil or vice versa. Greases, however, are generally better suited than oils under the following conditions:

1. When required to supply lubrication under dirty atmospheric conditions. Grease seals the ends of the bearings, thereby preventing dust and dirt from entering. This is especially important in the case of ball and roller bearings, as they are quickly ruined by a small amount of dirt.

2. For the bearings of inaccessible machinery, such as hoists, cranes, etc. Grease as a lubricant generally requires less attention than oil. Moreover, grease will insure some lubrication even when a bearing is neglected for some time.

3. Where freedom from dripping and spattering is an important consideration. For example, bakeries, paper mills, laundries, candy-making plants, textile mills.

4. Where operating conditions are extremely severe, that is, high temperatures, extreme pressures, low speeds, shock loading.

5. Where running clearances are largely due to wear or rough machine work, for example, cast-iron bearings of some farm machinery, construction and road building equipment, and coal-mine and quarry machinery.

Greases in general are not as stable as oils. They tend to break down under high temperature and speed conditions. Because of their heavier body or consistencies they offer greater internal friction than oils, and therefore are not as suitable for high-speed services or to other conditions where the friction power loss in bearings is an important consideration. The disadvantages of grease may be considered the outstanding advantages of oil.

Design of the equipment, operating conditions, and the various requirements of the process in which it is used, all must be carefully analyzed before an intelligent decision can be made as to whether a grease or an oil is the better lubricant.

Methods of Application

One phase of a lubrication problem that is frequently neglected, yet one that is often the most important, is the method by which the lubricant is applied. Those charged with the upkeep and operation of equipment are prone to blame any lubrication difficulty on the lubricant itself, whereas it frequently happens that the trouble rests not with the lubricant but with the method of application. Of course, often the operator has no choice of method of application, this having been decided by the designer of the equipment. In many instances, however, the operator can alter without much cost the method of application. Frequently, savings through reduced lubricant consumption, decreased maintenance and friction losses, will pay the cost of alterations in a short time.

Methods by which grease may be applied to bearings, gears, slides and other surfaces may be classified as:

1. *Hand application.* A paddle, swab or brush is

generally used where it is the practice to apply greases by hand. This is often done for open gears, chains, wire ropes, and some bearings. In general, hand application is wasteful and unreliable, as it is obvious that this method depends on the human element. Much more grease is usually applied than is required, the excess being thrown off and wasted. Moreover, due to negligence of operators the equipment usually operates for considerable periods without adequate lubrication.

2. *Grease-cup application.* This method is an improvement over hand application, but unless the cup is of the spring-compression type, it only feeds grease when the cap is turned down. The spring-compression type is so designed that a coil spring acting on a leather-packed plunger forces the grease into the bearing gradually. Rate and quantity of feed may be controlled by changing the spring load.

3. *Grease-packed bearings.* Frequently, bearings are enclosed so that they can be grease-packed. Usually some type of grease-retaining ring is provided at the point where the shaft extends through the housing. This system, if the retaining rings are maintained in good condition, insures comparative freedom from foreign particles entering the bearings. This method requires very little attention and is thoroughly reliable. It is frequently used for ball and roller bearing lubrication. These bearings should never be filled more half full.

4. *Grease wells.* Some bearings are designed with open tops, sides or bottoms and are lubricated by placing grease in the well to press against the revolving journal. Friction heat produced by the bearing causes the grease to melt slowly and thereby provide lubrication. Various block greases are widely used on this type of bearing, the blocks frequently being made to fit the cavities.

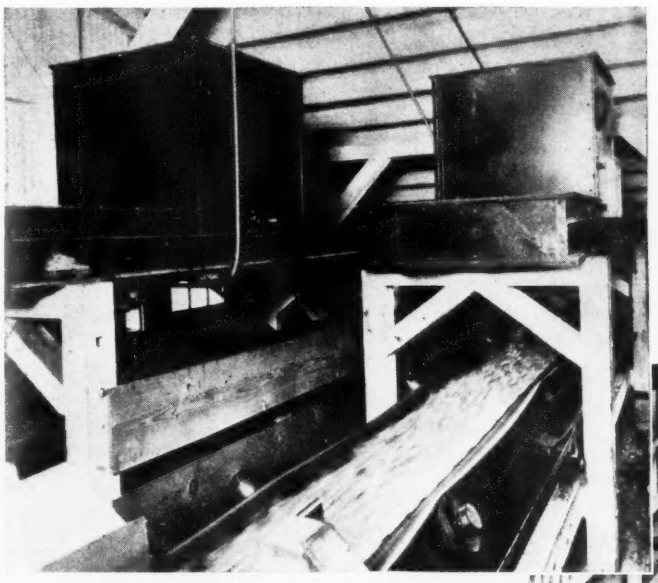
5. *Pressure systems.* Pressure systems may be relatively simple employing a hand operated "grease gun" or they may be quite elaborate and complex, using compressed air for forcing the grease into the bearings. Some modern pressure systems are capable of supplying grease at pressures as high as 10,000 lb. per sq.in. Special fittings are installed on the bearings to receive the nozzle of the gun. These fittings are provided with a check valve to prevent the leakage of grease after the gun has been removed. Such systems are excellent, because they are positive, insuring that the grease is delivered to the bearing surfaces and that any dirt or dust that has found its way into the bearing will be forced out.

Novel Feedwater Source

SOMETHING new in feedwater supply has been reported by "The Locomotive" of Hartford Steam Boiler Inspection & Insurance Co., as the current practice at a Stockton, California, milk condensing plant. Two wells, intended for the feedwater supply in a new plant, proved salty and unfit for boiler feed. Lacking city water service, the engineers decided to utilize water which is extracted from the milk during evaporation.

After being extracted from the milk, the water is collected in a tank where solids are settled out. The sludge is drawn off through a bottom blowoff pipe and any oil or fat is skimmed off with an open surface blow arrangement.

Because the plan is new, the company has arranged for frequent inspections of the boilers and also has retained a competent firm of feedwater chemists to make frequent analyses of both the raw feedwater and the boiler water.



Two grease-lubricated belt coal conveyors equipped with weightometers

Photographs of centralized grease-lubricating system by courtesy of The Farval Corporation.

Shaker screens and bucket-type coal elevator, grease lubricated from a central system

HOW TO BEND PIPE—I

Here is a simple procedure for large or small pipe bends with the usual small shop equipment. The author has had 25 years of experience in pipe work

By H. R. Riley
Salem, Ore.

THESE pipe bends are not intended to compete with those made by manufacturers of pipe fittings. A competent mechanic can, however, soon learn the fundamental technique of making emergency pipe bends or turns with usual shop equipment by this procedure.

Both plain and creased bends may be made without thinning the pipe wall. Bending occurs with the neutral axis on the outer surface of the bend; the extra metal on the inside is forced together, thus making the inner wall thicker and actually stronger. In creased bends, formation of the crease takes care of the extra metal. In either case, the original ellipticity of cross-section is retained, even though 90 deg. or more bends may be made with a radius equal to pipe diameter. Bends under a radius of four or five diameters are not recommended unless certain special requirements must be met.

Only experienced pipe welders should attempt this work, and they should have a reasonable knowledge of thermal conductivity of metals to enable them to compensate for expansion and contraction due to uneven temperature, stress and thrust. They must calculate proper bending temperature by observing the color and action of the metal. One welder and one or two helpers can handle all sizes of pipe up to 12-in. diameter.

I have bent up to 12-in. extra-strength wrought-iron pipe successfully by this method, and this is probably the largest pipe the average small plant will encounter. However, there is no good reason why pipe of larger diameter cannot be bent the same way, increasing the size of the handling equipment accordingly.

My experience has been that the proper way to learn this technique is to begin by making experimental bends on pipe around 2 in. in diameter, following the same procedure.

Simple as A. B. C.

The fundamentals of pipe bends by this method are as simple as A.B.C. Almost everyone is familiar with the effect of upsetting a piece of iron or steel. If a bar of iron is heated to a cherry red, as in Fig. 1*A*, at *C* in the center, and if force is then applied on both ends, *A* and *B*, toward the center, as in Fig. 1*B*, the center heated area will bulge or upset, making *C* larger and at the same time making the bar shorter.

My technique of pipe bending follows this principle. In Fig. 2*A*, assume a piece of pipe placed in position between two immovable supports, *A* and A_1, with a lever *B*. The welding flame is applied to the pipe surface at *C*, heating a narrow band extending around 90% of the top of the pipe. Fig. 2*B*. Force is then applied at *B*, Fig. 2*C*, upsetting or compressing the red hot band area and causing angular deformation of the metal at *C*. As *C* cools, shrinkage of the metal will

Fig. 1 — What happens when a bar with heated section is upset. Fig. 2 — Principles of pipe bending with Mr. Riley's technique

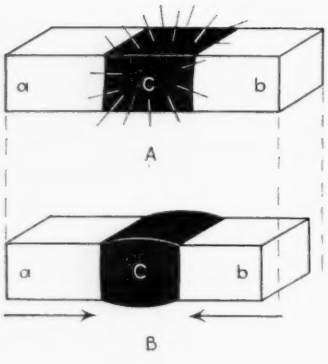


FIG. 1

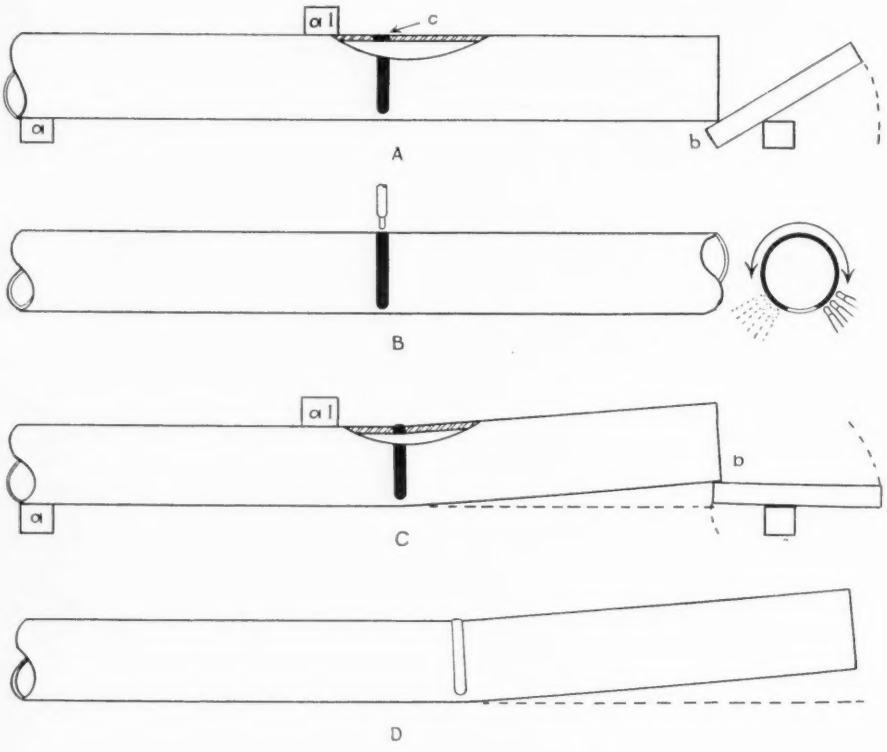


FIG 2

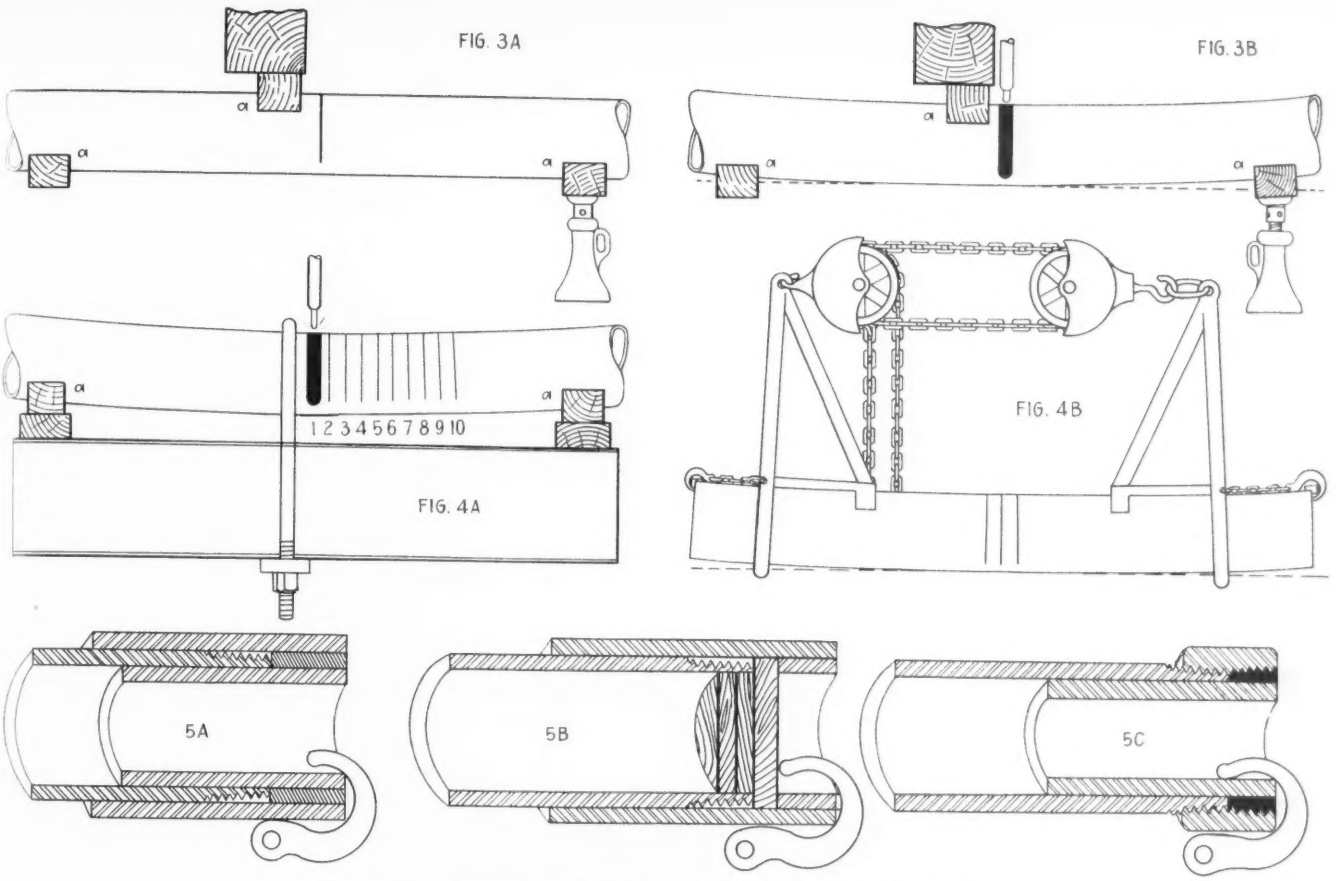


Fig. 3—First experiment. Fig. 4—Equipment for starting a bend and for finishing it. Fig. 5—Thread protectors for pipe ends

cause the pipe to bend more than the original curvature immediately after bending while hot. There will be practically no change in the 10% cold portion of the band at the outer radius, except the change in radius of curvature. The pipe will now look as it does in Fig. 2*D*.

This process is simply repeated at the proper intervals as required to make the desired radius and angle, allowing each operation to cool before the next is started. This is important, because otherwise a flattening or inward creasing of the pipe may result in the band last heated previous to the one being made.

A soapstone or chalkmark can be used as a guide when heating the band, and it is best to use two or three welding torches fastened together as a source of heat, in order that sufficient heat may be concentrated in the narrow band. A multiple-jet welding torch will be described later that is much more satisfactory for the work.

An Experiment

Begin the first experiment by anchoring the pipe with bending equipment tight to prevent pipe, blocks and jack from slipping, as in Fig. 3*A*. Tighten the screw jack until the pipe is slightly sprung, as in Fig. 3*B* (exaggerated) to prevent backward bending when heat is applied to the opposite side. If a considerable amount of bending is to be done, an I-beam, Fig. 4*A*, will be of some help for starting the first few bends until there is room to use chain blocks as in Fig. 7, or if bends are short and hard to make, a pair of bending irons and chain block, Fig. 4*B*, will greatly assist in the work.

If the pipe is threaded, some provision must be made to protect the threads with short pieces of pipe, as in Fig. 5*A-B-C*.

The chief consideration at this point is proper application of heat. If possible, the heated band should be brought to a cherry red and should be twice as wide as the thickness of the pipe wall, thus requiring the heat to be applied quite rapidly, constantly moving the torches the full 90% or approximately 320 to 330 deg. of circumference. Assume the pipe to be 12 in. in diameter with walls $\frac{1}{2}$ in. thick. Then the red hot area will theoretically be 1 in. wide outside and $\frac{3}{4}$ in. wide on the inside of the pipe. Possibly this band will widen out to $1\frac{1}{2}$ in. or even more, but this will do no harm. First try heating a short piece of similar pipe to determine the time necessary for the heat to penetrate through the wall. Also measure the width of the heated band on the inside of the pipe. Referring to Fig. 6*A*, the first application of the flame will start to penetrate the wall in a semi-circular manner as shown. Continued application of heat will cause the red to penetrate through the wall, as in Fig. 6*B*, with the red hot surface wider on the outside next to the flame. This is a natural line of penetration and must be kept this way to assure the upset being made on the outside of the pipe and not on the inside.

Continue heating along the line, moving the torch rapidly to prevent burning the metal. The metal surface will take on a shiny appearance when the melting

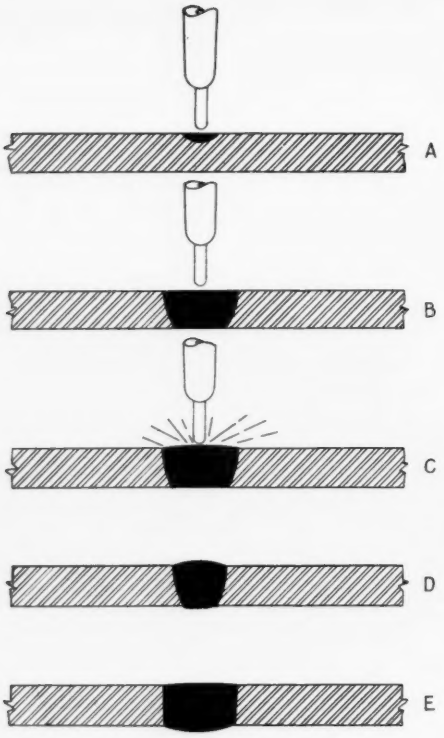


FIG. 6

Fig. 6 — What happens as the pipe is bent. Fig. 7 — Last few bends are made with chain blocks

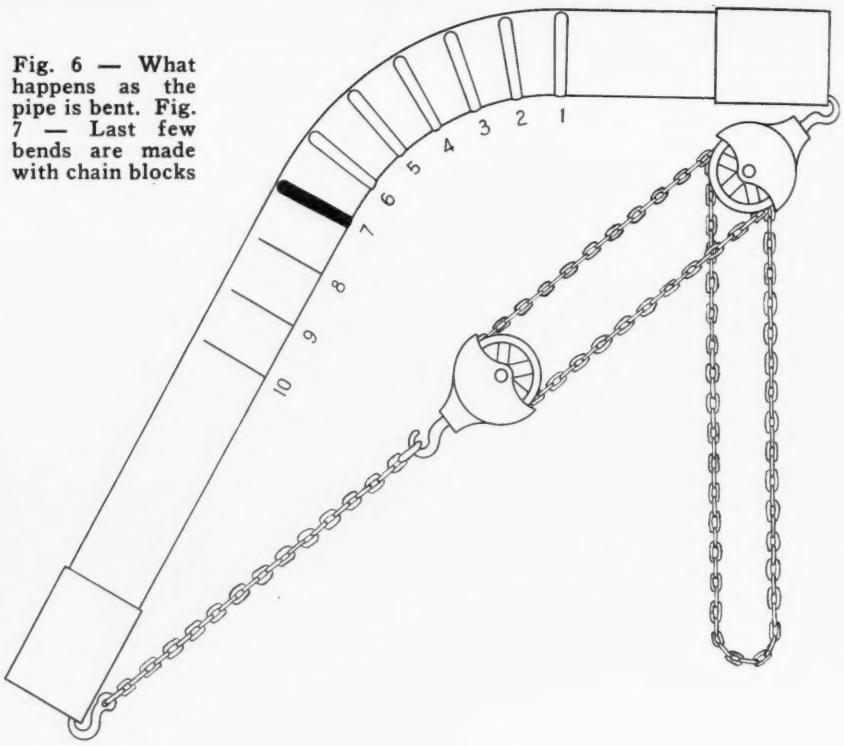


FIG. 7

point is reached. At the tip of the flame a few sparks may begin to appear from the near molten surface, as in Fig. 6*C*, which is now beginning to bulge slightly toward the flame because all of the heat has been applied to the outside of the pipe and the metal is stressed. Expansion of the metal, plus compression on the pipe, will assist this bulging. But above all, be careful not to burn or melt holes or craters in the surface. At this point increase the force on the end of the pipe with whatever equipment you are using. The finished upset area will take on the appearance of Fig. 6*D*, with the deformation or bulge practically all on the outside. (These illustrations, of course, are greatly exaggerated to simplify explanation).

Obtain a Heated Area

Obtaining a heated area, as in Fig. 6*C*, is very important and should be strongly impressed on the welder, otherwise should the heated area or band be too wide on either side of the pipe a part, or in some cases all of the bulge, will take place inside instead of outside, and the result will be as in Fig. 6*E*.

After one or two experiments with this pipe the welder should be ready to make a complete bend. Begin by locating the top and bottom center lines of the pipe. Then lay out the bends exactly as you would for semi-welded bends, remembering that the outside radius of the pipe will show no appreciable change in measurements. Chalkmark places to be heated. A template may be used to make each heat bend exactly the same number of degrees, allowing a correction for contraction on cooling.

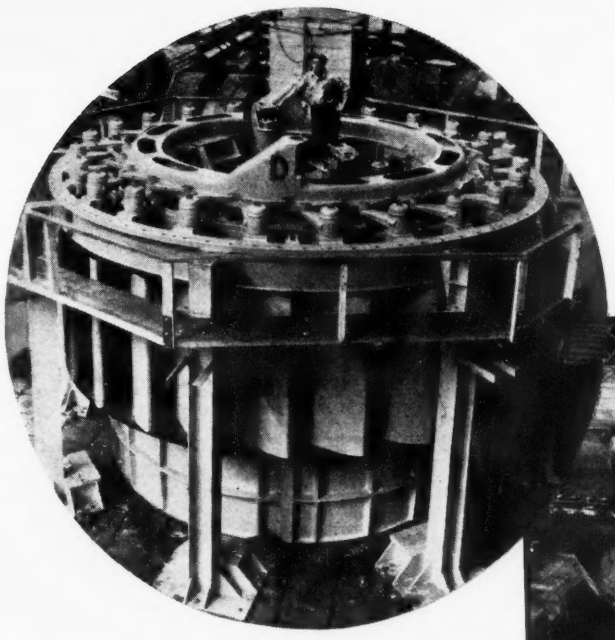
There are two ways to make the bends, one making the upsets in rotation as in Fig. 4, with bend No. 1, bend No. 2, and so on to No. 4 or No. 5, etc. The other is to start in the center and work outward, making bends alternately. In either case the last few bends can be made with chain blocks, as in Fig. 7, with caps or nipples to protect threaded ends.

This article will be concluded in our next number.

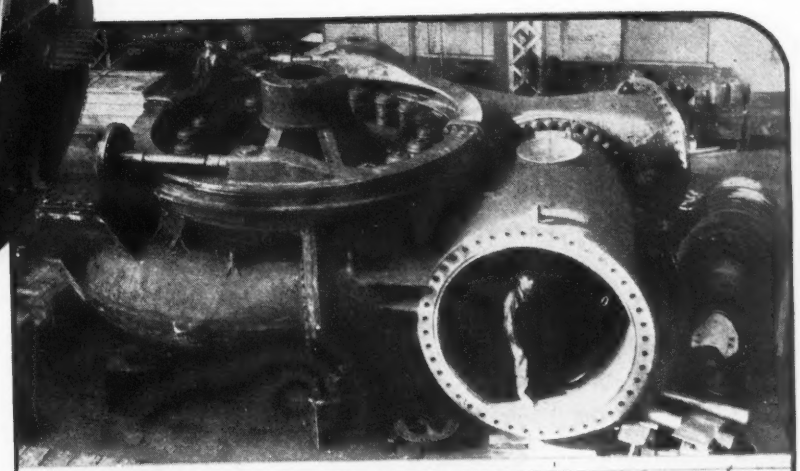
Telescopic Exciters for Norris

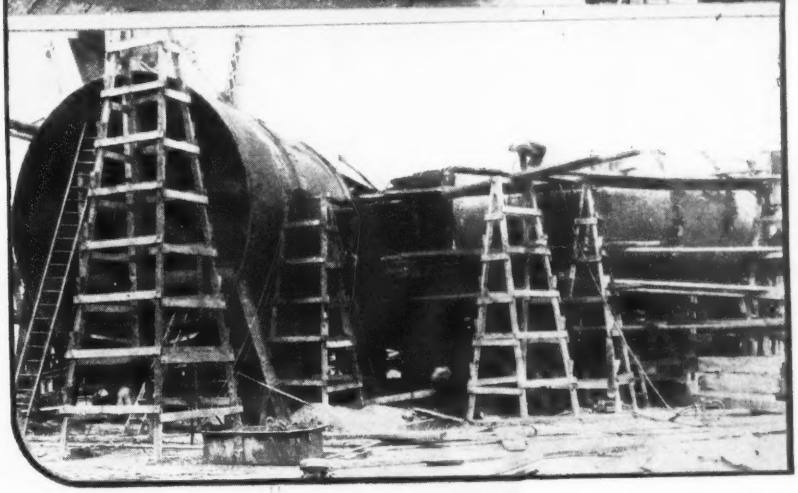
TWO umbrella-type Westinghouse generators now building for TVA's Norris Dam are each rated 56,000 kva. 0.9 power-factor, 13,800 volts, 2,340 amp. three phase, 60 cycles, 112.5 r.p.m. Maximum total temperature of windings is not to exceed 100 deg. C. as measured by temperature detectors and resistance on stator and rotor respectively. They will be totally enclosed and cooled by recirculating air through coolers and duct work located symmetrically around the periphery of the machine. By designing the ventilating system to take all air into the machines at their tops, a saving can be made in the foundation design as the usual bottom return air ducts are eliminated.

General design and arrangement of parts is the result of considerable study and planning to obtain a machine of minimum overhead room. Approximately 3.5 ft. reduction in overhead room results from using the so-called telescope exciter design. The term "telescope exciter" is suggested because of the arrangement of parts. The main exciter armature is mounted on a specially designed spider bolted to the top of the main-generator rotor, and the upper bracket supports its field frame. The pilot-exciter armature located inside the main-exciter rotor has its stationary member supported on the main bracket by an auxiliary bracket.



Left—One of four 6,800-hp. fixed-blade propeller turbines for Kanawha Valley Power Co. Two 20,-850-hp. plants will each contain 2 of these, and an adjustable-blade unit





HYDRO

Kanawha

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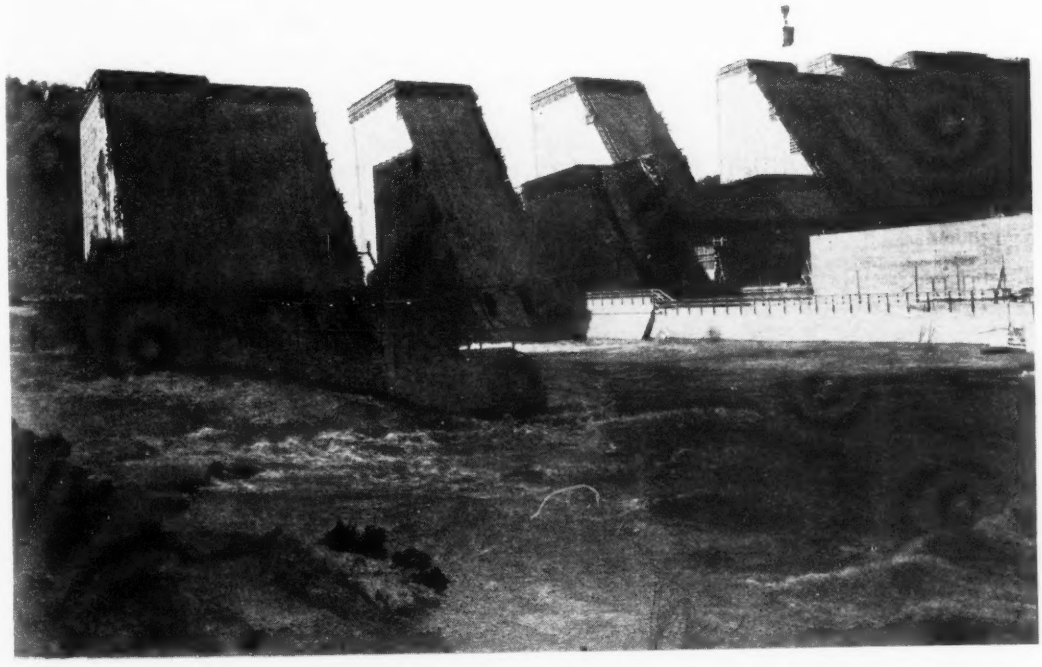

Top — Shop assembly of a 55,000-hp. turbine for Boulder Dam. This and four 115,000-hp. units comprise the initial installation

Above — Assembly of the first of two spiral casings for the 66,000-hp. Norris Dam turbines

Left — the 266-ft. dam itself

Upper three photographs courtesy Newport News Shipbuilding & Dry Dock Co., lower by Berenice Abbott

STEAM PLANT ERRORS

How Water Acts in a Boiler

*By Frank H. Browning, M. E.**

Engineer Examiner of the City of Seattle, Wash.

Chapter 1 (August *Power*) told the "what and why" of Mr. Browning's book. Here's a sample of how he "works out" with a candidate for an operating license. Put yourself in the candidate's shoes and see if you would make any of the same slips

AGAIN we must upset very general ideas of this trade. The action of hot water under pressure in a boiler is a very important subject for the engineers and firemen to know—thoroughly and clearly. A fraction of one per cent of practical men have a fair working grasp of a part of it. The same applies to prominent authorities, technical students, heating engineers, boiler designers and the like.

"What will happen when steam is let out of the boiler very fast?"

"The pressure will drop."

"Yes. What will the water do? Will it stand still?"

"It would probably go up and down in the glass. . . . You might lose your water when it stopped."

"While steam blows out fast, will the water go higher or lower or stay the same average level inside the boiler?"

"Let's see now. . . . The water level inside the boiler ought to go some lower, if you wasn't putting more in."

"Why is that?"

"Because it's using up some of the water."

"Do you know what happens to the water level when an engine pulls steam so hard the pressure drops?"

"Oh, sure. In a case like that the water is liable to rise." (The better men know this. Many have never noticed.)

"All right. A hard pull by the engine lifts the water. Do you believe the water in the boiler would know the difference if the same steam went out some other way—through the safety valve or some other steam pipe?"

"No—no, it couldn't, o'course."

"Then how can it go lower when steam blows out fast?"

"It wouldn't. It might rise. I didn't think of the engine."

"Will the water level lift very much?"

"No, not very much. It would raise some, though, if the water was too high in the boiler."

"Have you ever heard of any difficulty that might happen if the throttle valve is opened too quick, or when a sudden extra load pulls the boiler pressure down in a hurry?"

"Yes, sure. In a bad case like that, it's liable to pull some water over to the engine."

"Certainly. What will the water do to the engine?"

"It might wreck it—with a bad slug of water."

"How far is the water level from the top, usually?"

"Oh, that varies—somewhere around a foot and a half from the top, maybe two feet on some boilers."

"You must know that any water carried over from the boiler to the engine, has to rise as far as the main steam outlet, before it goes over in the line. Do you call that raising the water just a little bit?"

"I'd call that raising a plenty—for the water that carried over. It wouldn't all lift like that, though."

(Of course, the amount of change in the water glass will depend on where the bottom pipe from the water column connects onto the boiler. The glass will not show this action in the boiler if the lower pipe connects near the bottom of the boiler.)

"What makes the water level rise in the boiler?"

"Letting the steam out fast lifts the water."

"That doesn't explain it. Why does the water lift?"

"The rush of steam lifts it."

"That only tells WHEN it happens. Water rises WHEN steam rushes out so fast that the pressure

*Chapter 3, reprinted, slightly condensed, from Mr. Browning's book "Steam Plant Errors," published by the Stepler Company, Seattle, Washington. All rights reserved by the author. The next installment, Chapter 5, will be a question-and-answer dialogue on "Cutting in a Boiler."

drops. Tell me WHY. . . . WHAT MAKES the water level rise WHEN the rush of steam pulls the boiler pressure down?"

"It forms a vacuum in there."

"No. 120 pounds steam pressure is not a vacuum. That won't do. Make it definite. What lifts the water?"

"Why—a—there's a sort of a suction in there."

"You know you can't suck boiling hot water to a pump."

"No—but the steam going out fast pulls the water up."

"Do you believe the steam in the boiler is fastened to the water some way?—pulls it up like pulling on a rope?"

"No, not like that. The rush of steam pulls the water along with it—kind'a picks it up and carries it along."

"Oh, that's your idea. It may pick up a small amount of spray where the bubbles burst, and carry that along with the steam, especially in a boiler that is too cramped for steam space. Even so, would spray, like fog in the air, make the water level show higher in the water glass?"

". . . No—no, that couldn't."

"You have some notion that the big demand for steam from this boiler makes a high-velocity rush of steam at the outlet, and that the strong wind, cyclone or hurricane, will pick up and carry along some water —something like a big water spout at sea. Is that it?"

"Well, maybe—something like that, I suppose."

"Remember now, the water glass is out in front of the boiler, and we'll say the safety valve and main steam nozzle where steam is rushing out, are in the middle of the boiler or even farther back. Your strong wind would pull the water away from the ends of the boiler and stack it up in the middle. If it is the rush of steam that pulls the water along with it, as you say, would that make the level go higher in the water glass out in front, or would the water level drop in the glass?"

"That ought'a make it show lower, then . . . that's so. I never thought of that."

"Does it really go lower in the glass, when a sudden demand for steam pulls the pressure down?"

"No, it don't. It goes up in the glass all right."

"Certainly. Your pet theory doesn't work. Do you think the water climbs a step ladder to reach the steam outlet?"

"No, o'course not. Nothing like that."

"Well, how does the water get up there?" (Most ideas of this are as impossible as the step ladder. Some tell us that the water follows up the plates—as bugs crawl on the ceiling? One said "the water sort'a ferments." That may seem very foolish, yet it is not so bad. We often hear that "the water rushes toward the opening." A frequent reply is "the water expands."

"How do you account for that?"

"It's taking the pressure off."

"Why would it expand when the pressure is removed? Has it been compressed by the pressure?—like a sponge?"

"Well, no, not that way. . . . But it expands, and it shows higher every time that you fire up a boiler."

"That's true. Heating the water made it expand. Now the water is already heated and expanded. Would the drop of pressure make the boiler water hotter?—to expand it?"

"No. It wouldn't be the heat. . . . I mean, taking the pressure off lets it come up higher . . . and the sides of the boiler would come together some."

"Don't get a boiler mixed up with a rubber balloon. The high pressure can't possibly compress water or stretch boiler metal enough for you to notice in the glass."

(Many locomotive men believe that when some pressure is taken off the water, the pressure in the bottom of the boiler then forces all the water up. They tell us this leaves the crown sheet dry, to become badly overheated, and damage would occur when the water falls back on the hot sheets.

Engineers should know that the pressure is exactly the same in all parts of a boiler, except for the weight of the water, and the small effect of circulation. With this drop of pressure, the contents of the boiler could move or edge-in no more than an invisible part of an inch, when we would have nearly the original steam pressure on the water to push it back immediately).

"Suppose we consider a second boiler, just like the one in service, only this one is entirely cold. We put in half a glass of water, and put pressure on the cold water by turning in compressed air, say 200 pounds air pressure. Now, if we open the main valve and safety valve and blow out compressed air to take pressure off the water a lot faster than it could drop on the steaming boiler, do you think that would lift the cold water?"

(A very few men believe the cold water also would lift. Nearly all say)—"No, the cold water wouldn't lift."

"Good. We are beginning to get somewhere. You know the cold water would not lift like boiling hot water under steam pressure. How about the rush of steam pulling water with it? There would be no velocity to speak of right next to the water, with a surface hundreds of times the area of the steam pipe. No, the strong wind idea doesn't work. How about expansion or suction raising the water level when pressure is removed? Or the idea that bottom pressure pushes the water up when top pressure escapes?"

"No, sir. It can't be those things. I see now."

"Fine! Now we have room for good sense. Find me the real reason why boiling hot water rises in the steaming boiler when steam is let out rapidly."

". . . Well, Chief . . . you've got me stuck."

"You have stuck yourself for years, and it needs more work to pry you loose. . . . Ever have a home of your own?"

"Yes, sir. . . . Why?"

"Have you been in the kitchen when folks were cooking?"

"Sure."

"Suppose they pour a quart of soup into a gallon pan on the stove, and heat it until it begins to boil. No more fire will make it any hotter. Now suppose they turn up the gas flame and make a very hot fire

under the boiling soup, what do you think it is liable to do?"

"It's liable to boil over."

"Certainly. That's the real picture of what happens in your boiler when steam comes out rapidly."

"Well I'll be darned! . . . I never thought of it that way. . . . That explains it, simple enough."

"Does it look too technical for a steam engineer? Does the rush of steam pull the soup level up, or suction, or pressure at the bottom, and those other crazy ideas?"

"Well, sir, that kinda shows a fellow up." "It does a fellow good to find out what he knows." (Common remarks from very good men.) "Go ahead, Chief, I'll take it."

"Fair enough. Now, what makes the water level of the soup climb up so high it spills over on the stove?"

"Why—it expands, I suppose."

"No good. It can't get any hotter than boiling, and it certainly does not make more soup. In fact, it boils out some of the water. What makes it boil over?"

"That's because it is boiling so hard."

"Yes, but just why does it go up higher in the pan when it is boiling hard?" (All these steps seem necessary to put a finger on the exact cause. As the fire turns water into steam at the bottom of the pan, each bit of water takes up so much more room when it turns into steam that the liquid is forced aside by every bubble. The water level will rise a great deal and stay up just so long as the process of boiling requires extra space for the steam. One quart of liquid with two quarts of bubbles below the surface will reach to the three quart level in the pan.

Fortunately, the water in our boilers does not act as badly as the boiling soup, because clear water releases the steam bubbles easily, circulation helps them to reach the top, and the boiler pressure compresses them into very much smaller space.

Of course, with impurities in the boiler water, it is more like soup, or soap suds. It is then called "foaming" to distinguish it from the "priming" which occurs in clean water during the drop of pressure discussed here, or when forcing the boiler too hard.

Even though the pan of soup makes it look so clear, it is very important to study the boiler conditions more, because the real source of the disturbance is not yet in sight. Far too many accidents have come from raising the water level because few men realize the immense amount of steam formed when an extra demand comes).

"In the kettle of soup the extra hot fire made steam so fast it boiled over. But suppose we have not changed the fire at all under the steam boiler. When steam goes out faster than the fire is making steam, the pressure drops, and then the water lifts in the boiler—with just the same fire as before. What makes the extra quantity of steam to force the level higher, this time?"

"It must come from the hot plates and furnace walls."

"The plates and furnace and fire are no hotter than before. How can you account for the water boiling faster with the same fire, when steam goes out rapidly?"

Men do not see this, even when they know steam temperatures. Before the larger demand, all the water was hot enough to make steam at full pressure. But when the pressure drops, the water boils at a lower temperature. It cannot stay as hot and has no time to cool. The only way the water can get rid of its extra heat is by forming a lot more steam from the water.

Everyone knows the boiler gives out all the steam the system will take. It has to. It can't help itself. But the common error comes from supposing that the extra demand mostly uses steam already made and stored in the boiler. This stored steam could not touch the extra demands.

Let's start with a steady fire keeping steady pressure for ordinary needs. When more is needed, only one or two per cent of the extra steam comes from storage, not enough to bother with, and this same drop of pressure makes the water form 98% or more of extra steam requirements.

Except for this couple of per cent, the water boils just as violently when pressure drops, as if the fires were increased to supply all demands without loss of pressure. The action is exactly the same as in our kettle of soup. Everyone would expect the water to "boil over" if quick demands for steam had to be carried by intense fires. It is the false reliance on stored steam to meet sudden needs, which prevents most men from understanding this rise of water level when steam is pulled down rapidly.

Nobody could regulate his fires to hold even pressure during changing loads without this effect of the water. In our common type boiler, the water stores the heat for practically all extra demands—75 times more storage effect than the steam space above it. When the plant requires little steam the extra fire just heats the water, and when the plant needs more steam, practically all the excess comes out of the water from stored heat—boiling hard at higher level for the large demands and boiling slowly at lower level for the small steam needs, whether the fires are changed or not.

Although the "rush of steam" has nothing to do with raising the water level, it may have a lot to do with carrying over water after the steam formed below the surface has lifted the water level. No decent boiler should carry normal level high enough to give wet steam. But when this heaving brings the frothy surface too high in the drum, the "wind" in the reduced area may be strong enough to make quite a storm on our little lake, kick up a choppy sea, waves, whitecaps, and carry over the crests which come near the outlet.

Baffles and dry pipes may help with moderately heavy loads, but they can only make matters worse with the extreme rates of flow, bringing the most serious troubles much sooner.

"You cannot teach a man anything; you can only help him to find it within himself."

Galileo.

TEST YOUR OWN BOILERS—IV

How to Measure Feedwater

By Walter H. Wood
Combustion Engineering Co., Inc.

BOILER output, as pointed out in an earlier article, is determined by quantity of water evaporated, temperature of feedwater, pressure, and temperature in case the steam is superheated. It is necessary, therefore, that feedwater be measured accurately. Weighing water is usually more satisfactory than measuring it by volume, unless specially designed tanks are used. Size of tanks required will depend on the quantity of water to be measured. Two ordinary oil barrels can be used to test a boiler generating 10,000 to 12,000 lb. of steam an hour, if ample filling and emptying lines are provided. Fig. 1 illustrates the arrangement of two barrels on scales above a suction tank connected to the feed pump. The suction tank should have a capacity about double that of one of the measuring tanks. If the suction tank is too small it may be emptied when the feed pump takes water away faster than it can be measured. The suction tank should not have a large area and be too shallow, otherwise an error in measuring height of water at the beginning and end of the test may be noticeable in the results.

Measuring tanks should be set directly above the suction tank so the operator can at all times see the height of water in the suction tank. That enables one man to do the weighing on tests of small units.

Cylindrical steel tanks, having cone-shaped upper and lower sections, such as shown in Fig. 2, are most satisfactory for measuring feedwater. The coned upper section, with a cylindrical top about 10 in. in diameter and 10 or 12 in. high, insures against errors in measurement. If the middle section of the tank is extended up 12 or 15 in. above where the coned section begins, and a drain provided as shown, the tanks can be made to overflow at each filling, and chances for error in measurement eliminated. Quick-opening valves in the bottoms of the tanks insure rapid and complete emptying. Two such tanks made of No. 10 gage iron, and having a capacity of 1,500 lb. each, can be used to measure up to 50,000 lb. of water an hour with accuracy, if 4-in. quick-opening valves are used to empty the tanks, and 2-in. quick-opening valves are provided on a filling line under about 40 lb. pressure.

When tanks are used for volumetric measurement of feedwater, they should be calibrated three or four times after they are in place. In calibrating, the tanks should be filled to some predetermined level (until they overflow if the tanks just described are used), and then emptied through the discharge valves into a tank set on a sensitive platform scale. Temperature of water used in calibrating should be measured, because water at a different temperature may be used on the test and correction for temperature must be made. If, for example, a tank calibrated with water at 100 deg. holds 1,000 lb. its capacity with water at 150 deg. will be approximately 987 lb.

Ordinary rectangular or cylindrical tanks are not very satisfactory for measuring feedwater. It is difficult to fill such tanks to an exact height each time, even if hook gages are used. Tanks with flat bottoms are slow in emptying completely. If it is necessary to use such tanks for volumetric measurement, capacity should be sufficient to allow ample time for filling to the predetermined level and for draining completely. Rectangular and cylindrical flat-bottomed tanks are satisfactory if the water is weighed. Gross and tare weights of each tank of water can be made and accurate results obtained.

The suction side of the feed pump should be connected directly to the receiving tank. If there are branches on the suction line between the tank and pump, or in the discharge line, they should be blanked off or disconnected to make sure that only weighed or measured water is delivered to the boiler. If a closed feedwater heater is in the line between the pump and the boiler, the heater must be tested to insure against leakage. Temperature of the water must be taken after it has passed through the heater, to determine how much heat is added.

Use of meters, for measuring either the amount of steam generated or the quantity of feedwater, is not recommended. Some plants do use meters for testing when high accuracy of results is not considered important, but in such cases the meters are frequently calibrated. If it is not possible to weigh or measure the feedwater on a test for efficiency, a steam flowmeter can be used for indicating the rating and efficiency determined by heat balance.

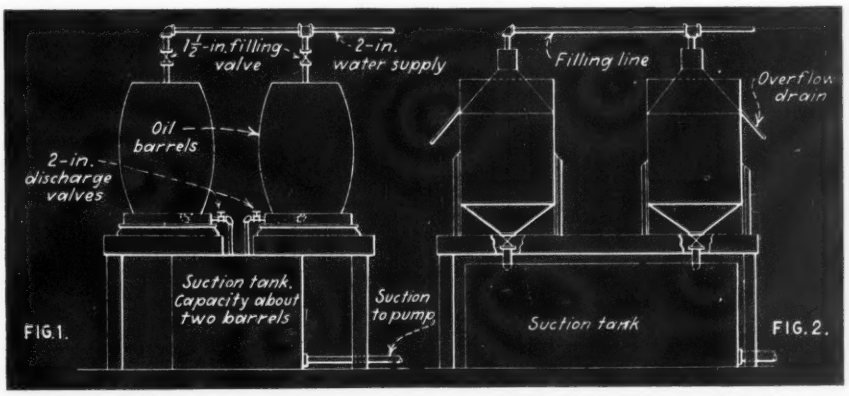

Fig. 1 — Barrels, scales, suction tank and piping for weighing up to 10,000 or 12,000 lb. of water per hour. Fig. 2 — Arrangement of measuring tanks with coned upper and lower sections for accuracy and speed

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50,000 TONS OF EXPERIENCE WITH BUCKWHEAT NO. 4

"Smaller size" means "cheaper" in anthracite coal. The frugal householder burns pea coal, or perhaps buckwheat No. 1 with a blower. Many industrial plants burn buckwheat No. 3. Mr. Johnston shows how to go a step further in cutting fuel costs and burn No. 4

*By W. S. Johnston**
Mechanical Engineer,
Pottsville, Pa.

BUCKWHEAT No. 4 is a newcomer. The particles of this anthracite size will pass through a 3/32-in. round-mesh screen. The fuel, as discussed in this paper, is a prepared size, cleaned to limit the ash content, and sized to some predetermined standard. It does not include culm.

It is now possible to report the results of 2½ years of experience with this fuel in the plant at St. Nicholas, Pa. This is owned by an anthracite producer and supplies steam to adjacent collieries and a central preparation plant. The St. Nicholas plant is a pioneer in the region, not only for 450-lb. pressure, but because large output at this pressure is developed with buckwheat No. 4. Fundamental considerations in its design were simplicity and ruggedness of the equipment to assure continuous service at high capacity, if necessary. Without elaborate heat recovery equipment, a highly efficient plant was attained.

Steam is supplied by two inclined-tube water-tube boilers. An extra lower drum, and extra tubes in the rear bank, constitute an integral economizer within the boiler-setting wall. The boiler has 11,062 sq.ft. of heating surface, and each economizer 3,459 sq.ft.

The furnace is 18 ft. wide. Furnace equipment is two traveling grate stokers of the carrier-bar type. Each stoker is 18 ft. wide by 24 ft. 10 in. long, with 424.5 sq.ft. of effective grate area.

Forced Draft

Forced draft for each unit is supplied by a 67,000-c.f.m. fan, and induced draft by a 125,000-c.f.m. fan.

Boilers have the rear-arch, narrow-throat type of furnace now widely used on anthracite-fired units. The water-cooled wall panels in the side walls, opposite the throat, are bare their entire length. Front walls and rear arches are entirely of refractory material without water-cooling, a type of construction justified because of large furnace volume (4,000 cu.ft.) and a high quality refractory

The four-pass baffling is curved to give streamline flow to gases. At 410% rating, the maximum developed so far, exit gas temperature is only 490 deg. F., and total draft loss, 2.8 in. of water.

Each stoker has seven compartments from front to rear to distribute air supplied for combustion. Each compartment has a control damper on each side, and sifting removal jets for cleaning out the finds that sift through the grate surface. Fines carryover is removed from gas passages at four points. That from the second-pass hopper and the hopper between the two lower drums is returned to the fuel bed. That from the other two hoppers is discharged to the ash sluice.

Operation is practically automatic. Stoker feed, undergrate air pressure and negative furnace draft are automatically controlled.

The two units are handled by one stokerman on each shift. His principal job is to observe the condition of the fuel bed. At times of load changes he supplements the automatic control, manually changing the ratio of fuel feed to air supply by adjusting the needle valve for each stoker. This compensates for the time lag between the change in drum pressure and the response of the control system to that change.

The stokerman also adjusts the air dampers on individual stoker compartments.

Fuel Delivery

The method of delivering the No. 4 buckwheat fuel is unique. Fuel is mixed with water at the central breaker and pumped to the steam plant through 1,800 ft. of 8-in. pipe. Water flow is constant at 1,500 g.p.m., regardless of quantity of fuel. Upon arrival at the steam plant, the mixture of water and solid fuel passes over agitated dewatering screens. The water is shaken out and the fuel is distributed by a flight conveyor to four bunkers with a combined capacity of 550 long tons. Water is reclaimed and stored for sluicing ashes. Any excess water is returned to the central breaker for re-use.

Ashes are dumped over the rear end of the stokers directly into sluice-ways through which water flows continuously. The ashes are dewatered in a hopper, withdrawn from the bottom thereof to an under-cut gate and lifted by a bucket elevator that discharges the ashes onto a refuse belt from a cleaner plant for final disposal on a rock bank.

The following comments, based on 2½ years of operation, burning 50,000 tons of No. 4, should be of interest:

First, remember that the No. 4 fuel is a carefully prepared and sized product, no different from barley and larger sizes, except in size. Like barley, No. 4 has a definite load limit, but at a lower level than barley. Probably next to its ash and moisture content, the matter of size is most important in determining its scope of application.

According to experience at St. Nicholas, ash preferably should not exceed 15%. A minimum ash of about 10% is required to keep the rear of the stoker covered as protection against radiant heat.

As the No. 4 comes off the end of the dewatering screen it is dripping wet, containing 30% or more moisture. It is dried to not more than 15% total moisture. No minimum limit on moisture has been determined, but it must be something more than bone dry, otherwise it would be blown off the grate. Drying period is usually 8-12 hr.

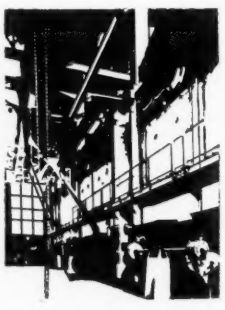
With a maximum size of 3/32-in., the No. 4 buckwheat contains particles as small as 100 mesh. Oversize, or plus 3/32-in., should be limited to 10%. The percentage through 3/64-in. should not exceed 10%. 80%, therefore, should fall between 3/32-in. and 3/64-in. To increase the load-carrying capacity of No. 4, the greater part of the 80% should be plus 1/16-in. For lower capacities the plus 3/64 may predominate. These specifications are based upon experience at St. Nicholas and may not hold good under other circumstances.

Easy on Refractories

Buckwheat No. 4 has been found to be an admirable fuel within its load-carrying capacity, for a uniform steady load, such as is afforded by central heating plants, laundries, ice and refrigerating plants, some industrial plants whose loads are fairly constant, and base-load steam-electric plants where high overloads are not attempted. It is particularly advantageous, because it must not be blown too hard by undergrate air pressure, and hence the furnace refractories are not severely punished. For such applications furnaces may be designed for a burning rate of 25-30 lb. per sq.ft. effective grate area.

In plants such as St. Nicholas, where heavier power loads are carried and the load is widely fluctuating, No. 4 is a good fuel, but the fuel bed requires constant and skilled attention if the plant is operating near its load-carrying limit. No attempt must be made to raise the limit by increasing the under-grate air pressure. To meet such loads a burning rate of 30 to 35 lb. per sq.ft. may be necessary, but the maximum can be carried three or four hours only.

Before deciding to use No. 4, the design of furnace and furnace equipment should be scrutinized. Many existing plants now heavily loaded could easily shift from barley, their present fuel, to No. 4. No small part of the success of generating power with No. 4 at St. Nicholas is due to the fact that the plant was designed for this fuel with ample grate area and furnace volume, and proper arch and wall arrangement.



*Abstract of paper presented May 13 before the Anthracite-Lehigh Valley Section, A.S.M.E.

"HOT SPOT" STRAIGHTENING OF DIESEL CRANKSHAFTS

An outline of current procedure, and opinions of prominent diesel manufacturers regarding the process

SOME months ago, *Power* received the following inquiry from a reader:

WE ARE *encountering a number of new problems in overhauling our many types of diesels, ranging from 1-cyl. horizontals to many-cylindered verticals. We have always "miked" crankshafts in order to test and correct alignment, but we have recently come to the conclusion that our former procedure is not adequate. Dial gage readings taken on the journals of many shafts have shown that many are bent to some extent, and regardless of main bearing level cannot hope to run true. We therefore must develop some more accurate procedure for checking and straightening crankshafts. What procedure can we use and how can we interpret our findings? Is the so-called "hot spot" method of value? If so, who invented it and where and with what success has it been used? Is the resulting shaft permanently corrected? What is the theory and technique? Is the data secured by dial gage readings plottable to permit mathematical or graphical analysis in order to locate points of maximum deflection?* —E. R. O.

After this inquiry was published in the October, 1934, number of *Power*, a number of replies were received, four of which were published on pages 689-690 of the December, 1934, number. These indicated that the "hot spot" method is the only accurate straightening method in use today, that shafts so treated can be "permanently" corrected, that the process has been used for 16 years, that permissible misalignment is about 0.003 in. between readings taken with a dial gage with the crankshaft at top and bottom centers. The Hartford Steam Boiler method of testing alignment and that for testing stress in a shaft are also given. The editors have, in addition, communicated with several diesel manufacturers and undertaken additional investigation. Results of their survey are as follows:

The "hot spot" method of straightening is based on the fact that heat applied to one side of a bar will cause the bar to bend toward the point at which heat is applied until the bar cools, at which time it will draw back beyond the original position, away from the point where it was heated. Heating the bar causes expansion of the metal in the area being heated and thus creates a hump *toward* the flame. Meanwhile, the unheated side of the shaft away from the flame is acting as a spring, trying to force the bar back to its former position. Since the heated area is plastic the metal there is upset by the compressive stress set up by the cooler back section. Thus when the bar cools again, the section that was heated is shorter and causes the bar to assume a "set" *away* from the point at which flame was applied.

The only tools required are a dial indicating gage measuring to the thousandth of an inch and an oxy-acetylene welding torch. The pistons are taken out to free the shaft of extraneous weight, and main bearing caps are removed to permit checking the shaft with a dial indicator. One or more bottom main-bearing shells are removed at the point at which the shaft shows greatest deflection, to prevent the bearings from holding any deflection out of the shaft. Then the shaft is checked with a dial indicator to determine the degree to which it is sprung.

Procedure

It is most important to move the indicator along the shaft, locating the point of greatest deflection, and then working from this point. After the point is located, the indicator is moved an even number of inches and another reading taken to determine the degree of deflation (in thousandths) per lineal inch along the shaft. This value is divided into the greatest measurement in thousandths to locate the distance in inches of the point where the bend starts from the point of greatest deflection. In other words, if the maximum bend is 0.050 and deflection per lineal inch is 0.0010, then 0.050 divided by 0.0010 equals 50 in., and the point of bending is 50 in. from the point of maximum deflection. The shaft is then set with the point of maximum deflection up and the arc of the bend downward. The indicator is again set up where the greatest deflection reading was obtained. As heat is applied the shaft bends upward into a still greater arc. Heat should be continued until the indicator shows upward travel of the shaft of about twice the amount of the bend. The shaft is then allowed to cool, barred over and measured, the process being repeated until the shaft is deflected a few thousandths *beyond* its true axis (to allow for springing and heat strain. The heat puts stresses in the shaft where it is applied. Some will relieve themselves in operation, permitting the shaft to go a few thousandths out of line. Allow about 10% of the amount of the bend to offset this; that is, draw the shaft this much beyond its axis.)

Bending and distortion of a crankshaft is caused by main bearings out of alignment, and in operating horizontal engines with loose main bearings as the result of an accident due to a failure of a part, improper heat treatment in manufacture of the shaft, or failure to normalize the stresses in the forging before final machining of the shaft.

Replies

Here are abstracts from the replies of diesel manufacturers:

"I have never attempted to straighten a crankshaft of any size. I have straightened some small crankshafts of 3 in. and under in a heavy engine lathe, but, of course, this could not be applied to a shaft of any size.

"Some time ago, in your publication, you described the straightening of a large shaft in a vertical water turbine, and this is the procedure they used.

"I believe the firm that has had most success in straightening crankshafts is the Washington Iron Works at Sherman, Texas. These people make a specialty of repairing crankshafts and wrecked engines in the field."

Take Out First

"We agree with you that small size shafts can be straightened as outlined in your letter, but as you probably know, most of our diesel shafts are 10 in. and over, and we do not make a practice of trying to straighten them without removing them from the engine. After they are taken out we use the same method, namely, the 'hot spot.'

"The method used by the Hartford Steam Boiler people, in our opinion, is also satisfactory."

Don't Believe In It

"We never were in favor of such a procedure, as even if one succeeds in straightening a shaft out by any means of one-sided added strain, there is no guarantee that the shaft will stay straight, as time will act as it does in aging castings and will permit readjustment of the strain gradually. That means that the shaft will again change shape.

"We feel that the only way to get a good job would be to either fit a new shaft, or to re-machine all over journals and pins of the old one, and fit new undersized bearings, if the shaft can safely stand such a decrease in strength and stiffness.

"We have never used this or any other method for straightening our shafts, except turning them undersize."

A Tricky Job

"Repairing the crankshaft as suggested in your letter is a tricky job, and there are two kinds of men doing it, those who know how and those who don't. I would not advise any and everybody to undertake the repair of a shaft by this method."

Records of Use

"We have no direct experience with this method, but have authentic records of its successful use in straightening steam-turbine shafts and a few oil engine shafts. Some of these shafts have been in operation eight years since being straightened, and have retained their straightness.

"As to determining the location or locations of maximum deflection, this is, of course, much easier in the case of a plain shaft than in the case of a shaft with a number of cranks; but certainly the determination of this point should not present any difficulty to an intelligent mechanic provided with the proper dial indicator. It is not sufficient to assume that the bending has taken place at a single point, but it may be found that there are two or more bends, possibly at different angles in the circumference."

Successful

"Our method of checking crankshafts is by the use of a dial gage and also by using a dial gage between the cheeks of the cranks and taking the relative measurements while rotating the shaft on complete revolution, taking the reading at the four quarters.

"We have had very little experience with straightening shafts ourselves, although we understand that some of the pipe-line companies have used this method, and, also, it is our understanding that the Washington Iron Works, Sherman, Texas, have used this method, and all of them have had rather successful results."

SPEAKING OF POWER

● THE ENGINEER may be the dynamite that blasts out a path for progress, but don't forget the part played by the executive who sets off the charge. All good manufacturing executives are fuse lighters. . . . Example 1: Some years back a great Midwestern Steel mill began rolling the metal in endless sheets like paper. "It can't be done," steel experts had told their executive, but it was done because this particular executive would not take no for an answer. . . . Example 2: A story of today as I heard it first hand up in New England a couple of weeks ago. The company, it seems, had been making rubber belting for years by the time-honored process of flat-press vulcanization. Pretty good, but not got enough, because unequal stretch and double vulcanization at overlaps were constant risks. Again enter the fuse-lighting executive. He demanded the impossible, continuous vulcanization by a rotary press. He demanded it so persistently that it became easier to find the answer than say "no." Once more engineering dynamite, plus a fuse kept lighted, has cleared a new path—this time for power.

James O. G. Gibbons, consulting engineer in New Jersey, writes in to remind me that engineers and salesmen (chiefly salesmen, I guess) are still talking about the "efficiency" of radiators. As he sees it (and as I see it) a radiator, good or bad, always has an efficiency of 100% unless its trap is leaking steam through to the return line. Why confuse effectiveness with efficiency? . . . You can put a blanket over a steam radiator and it will still be as *efficient* as it was before. Its *effectiveness* in heating the room will be greatly reduced, but you don't lose any heat you pay for, because the blanket cuts down steam consumption in exact proportion to reduction of heat supplied to the room. Efficiency is the ratio of what you get out to what you put in. A radiator always gives out what is put in.

"Neither rain nor snow nor heat nor blue of night stays these couriers from the swift completion of their appointed rounds." . . . Most of us can't quite live up to this romantic post-office ideal, but it has been interesting to note here and there men who have been plowing along right through the depression, always getting a little more than their share of business, always making enough to keep the wolf from the door. Now that things are picking up generally, these same men seem to be holding their lead. . . . I suppose it's partly luck, but there must be an element of greater skill or tenacity or something. Or perhaps they don't spend so much time talking politics. . . . On a recent visit to an old Eastern city, I encountered many examples of this kind. I also saw others where the native virtues of the rock-ribbed region have become a vice. Some business men there, as elsewhere, are indulging in an orgy of caution. Sitting out under the trees eating wooley worms and rather hoping that nobody drops an order over the transom. . . . All of which is merely another form of dissipation.

Which reminds me that a bright school boy has answered the eternal question. When the psychological examiners tried to upset him with the favorite "How long is a piece of string?" he came right back with a fitting answer, "Twice the distance from the center to either end." Hats off to this boy, assuming that he did not crib the answer from some adult. . . . With such samples of real brilliance cropping up here and there, I am still puzzled to explain why so many American businessmen are under the impression that they cannot afford to save. There are apparently thousands of cases where a modest investment in instruments, new firing equipment, insulation or what-have-you, will pay itself back in from six months to three years and then keep on yielding from 33 to 200% on the investment for the next ten years, and where the men concerned won't spend the money. . . . There are, of course, only two possible logical excuses for such inaction. One is that the owner expects to be out of business inside of six months or three years (as the case may be). The other is that he hasn't the money and cannot beg, borrow or steal it. This latter explanation, by the way, is the one most frequently given. . . . Now that it is possible for almost any industrialist to borrow from his bank from $2,000 to $50,000 for modernization under reasonable conditions, it becomes possible to say whether the "reason" is merely an alibi.

A recent survey by the National Industrial Conference board showed that labor costs per man-hour have risen 40% since July, 1933. All indications are that the trend will continue—can't be stopped and perhaps shouldn't be. But nobody is stopping any manufacturing plant from cutting power costs. And there's plenty of opportunity; we estimate 50 cents on the dollar in the average plant.

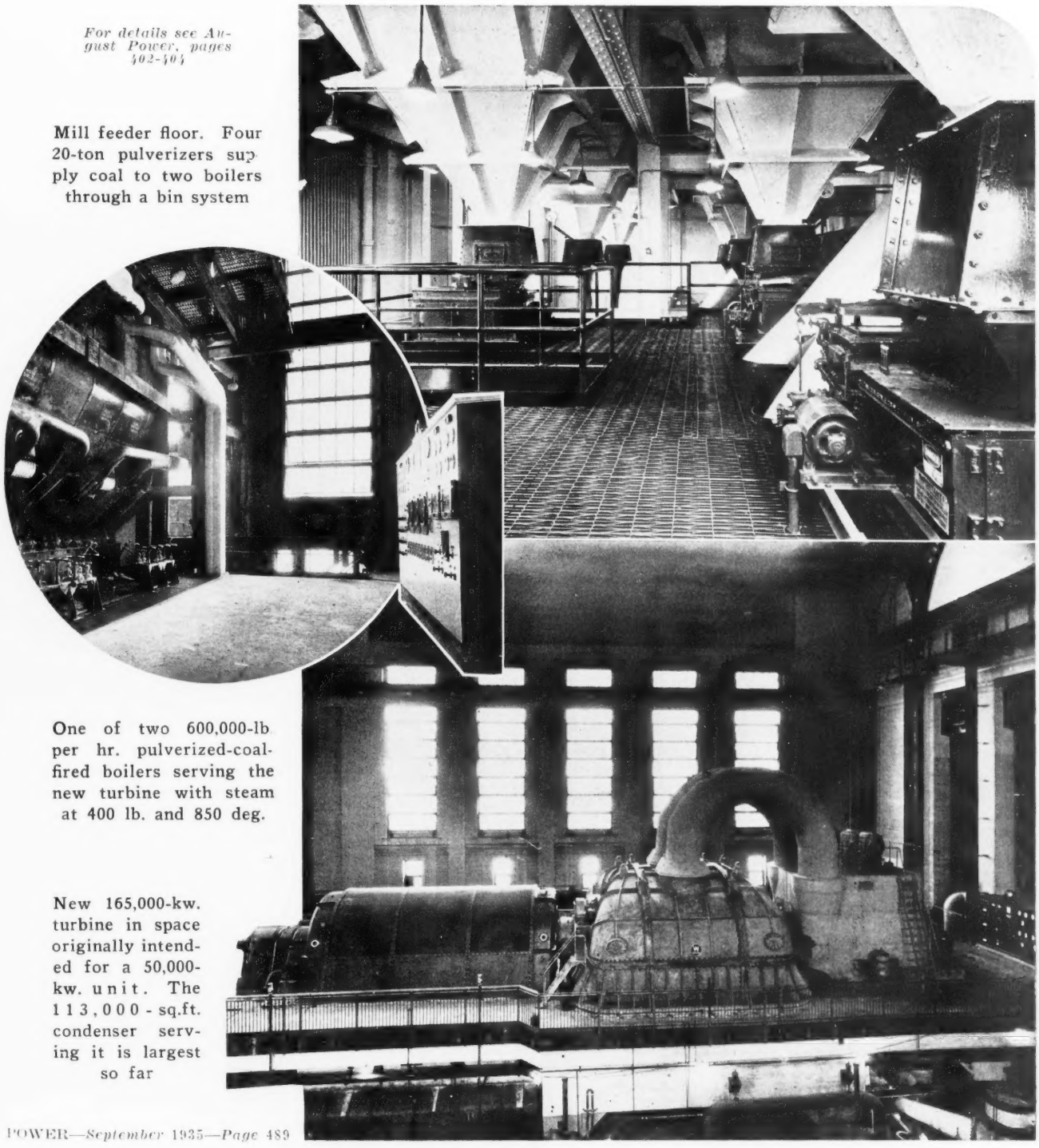
Early air conditioning in textile and tobacco plants was for the sake of the product, not the worker. Today we find straight comfort jobs here and there in industry. For example, Ford has begun to air-condition machine shops and foundries at River Rouge. My guess is that Ford will get his money back twice over—once in more contented workers, and again in greater output and better quality.

PHIL SWAIN
Editor

THE NEW RICHMOND

The 165,000-kw. unit added to this station of the Philadelphia Electric Co. is the only large addition to utility capacity made so far this year

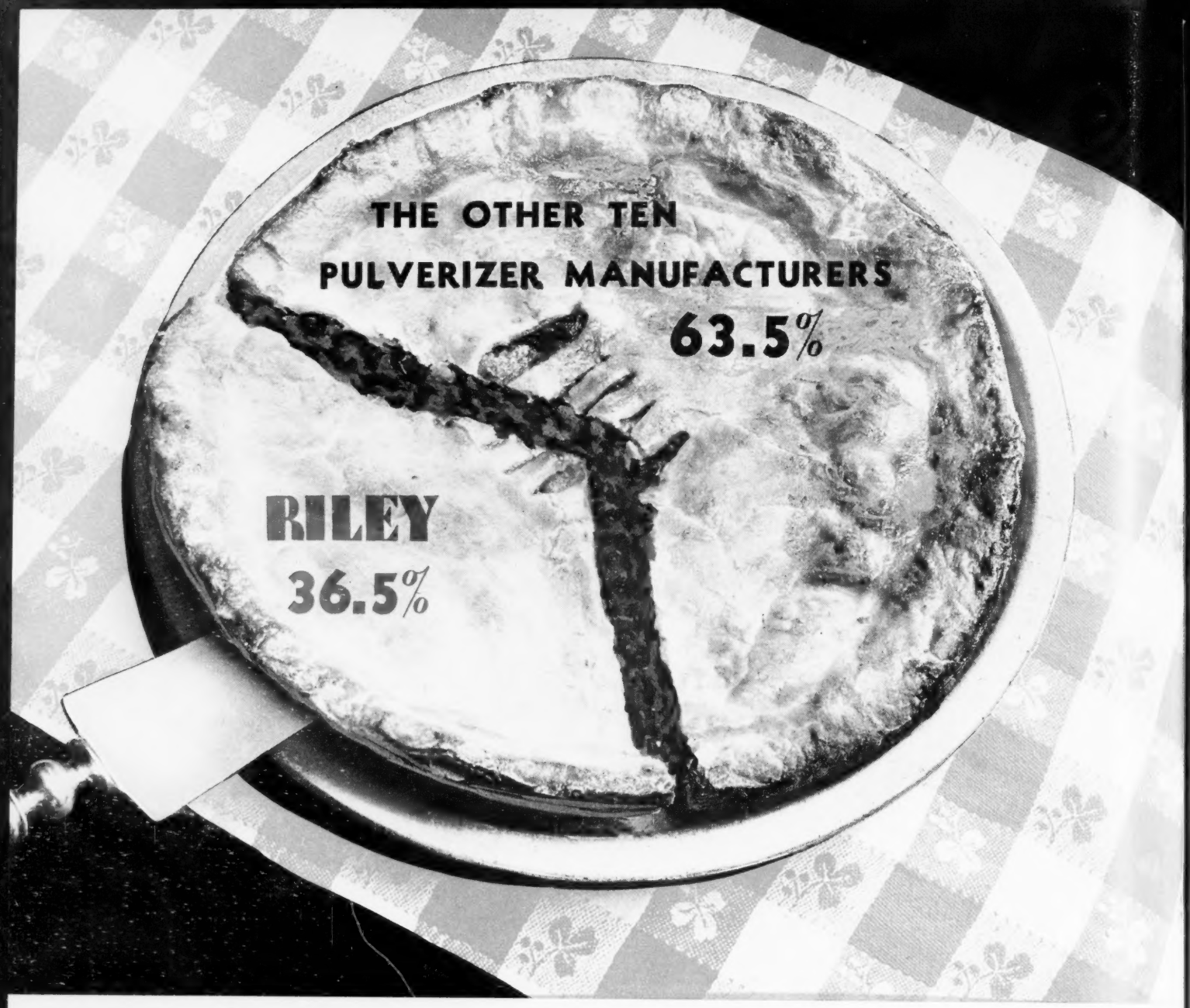
For details see August Power, pages 402-404



Mill feeder floor. Four 20-ton pulverizers supply coal to two boilers through a bin system

One of two 600,000-lb per hr. pulverized-coal-fired boilers serving the new turbine with steam at 400 lb. and 850 deg.

New 165,000-kw. turbine in space originally intended for a 50,000-kw. unit. The 113,000-sq.ft. condenser serving it is largest so far



Riley's Slice of the Pulverizer Pie

We feel the engineering profession is entitled to know these facts about coal pulverizer sales for installation with water tube boilers. Of the total sales of the eleven pulverizer manufacturers to date in 1935, based on coal pulverizing capacity, Riley sold 36.5%, leaving only 63.5% to be divided by the other ten manufacturers. Could there be any better evidence of Riley Pulverizer Superiority.

The SWING *to* **RILEY** *continues*

A Few Recent Installations

American Laundry Machinery Co.
Owens-Illinois Glass Co.
Carbide & Carbon Chemical Co.
Titanium Pigment Co.
Beechnut Packing Co.
Crompton & Knowles Loom Works
Arnold Print Works
Crystal Tissue Paper Co.
Ames Worsted Mills
Norton Company

Outstanding performance has created this decided preference for **RILEY PULVERIZERS**

When you purchase Riley Pulverizers you are assured the utmost in economy and reliability by the performance of these pulverizers in hundreds of existing plants both here and abroad.

The selection of Riley Pulverizers by such a large majority of the recent installations was based on

1. General design
2. Fineness of pulverization
3. Sustained and consistent fineness maintained throughout life of pulverizing elements
4. Low power rate
5. Flexibility—wide load range
6. Quiet, vibrationless operation
7. Low maintenance
8. Ease of lighting
9. Ability to handle wet coal
10. Reliability
11. Record of and satisfactory performance of the large number of existing installations
12. Organization behind the machines

Today's requirement for reduced costs demands the modernization of power plant equipment. Have a consulting engineer make a survey of your power plant. When you consider this problem let Riley engineers aid you. Riley manufactures not only pulverized coal equipment but also boilers, stokers and all of the component parts of the complete steam generating unit.

RILEY

STOKER CORPORATION, WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT
CINCINNATI ST. PAUL ST. LOUIS ATLANTA KANSAS CITY CHICAGO LOS ANGELES

COMPLETE STEAM GENERATING UNITS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS - WATER-COOLED FURNACES
PULVERIZERS - BURNERS - MECHANICAL STOKERS - STEEL-CLAD INSULATED SETTINGS

Further Evidence of the Outstanding Performance of Riley Pulverizers

A few of the many repeat orders

West Virginia Pulp and Paper Co
11-17-1927—2
5-15-1928—4
11-1-1928—4
1-15-1929—1
4-24-1929—5
12-20-1929—2
11-9-1933—3
12-2-1933—3

Weirton Steel Co.
5-19-1930—3
10-25-1932—1
10-2-1933—2
8-2-1935—1

Morrell Packing Co.
4-13-1929—2
4-24-1930—2
5-23-1935—2

Beechnut Packing Co.
4-29-1929—1
10-18-1934—2
11-28-1934—1

Edison Electric Illuminating Co.
7-27-1929—4
3-30-1931—2

Central Paper Co.
12-11-1929—1
4-15-1931—1
11-3-1932—1

Hartford Electric Light Co.
8-11-1927—1
1-24-1930—4

S. D. Warren Paper Co.
4-8-1931—1
8-17-1934—1

Arnold Print Works
11-8-1928—2
12-28-1934—4

Oklahoma Gas & Electric Co.
3-2-1929—4
4-19-1930—2

National Cash Register Co.
3-20-1926—1
5-24-1928—1
4-18-1929—2

Fitchburg Paper Co.
8-5-1926—2
3-18-1930—2

Lincoln Oil Refining Co.
12-8-1931—1
4-5-1932—2

of Riley Steam Generating Units

West Virginia Pulp and Paper Co., Luke, Md.
West Virginia Pulp and Paper Co., Cov., Va.
Forstmann Woolen Co., Garfield, N. J.
Forstmann Woolen Co., Passaic, N. J.
Pennsylvania Sugar Co., Philadelphia, Pa.
Savannah Sugar Co.
Kalamazoo Veg. Parchment Co.
Continental Distilling Co.
General Aniline Co.
German Brewery Co.
American Oak Leather Co.
Columbia University
Large Eastern Oil Refinery
Times Building, Los Angeles
Worcester Polytechnic Institute

'T WORKS, BY JIMINY

Or, Rube Goldberg of the Blue Ridge

There was a young man of Tieview,
Whose farm left him little to do.
His inventive young mind,
Made a boiler, we find,
Of whatever his nose led him to.

BACK in 1900, some West Virginia mountaineers furnished ties for the Bellington & Beaver Creek Railroad. Rejects were piled along the right of way and burned one night. In the glare of the fire the mountaineers picked a townsite and called it Tieview. Once the town was prosperous, but today it's just a clump of fallen houses.

Thirteen years before, one of the mountaineers had settled there. Let's call him Jones. In 1907 he had a son, Raphael, who managed to get through 8th grade in the mountain school. Two years clerking in an Akron, Ohio, grocery store got him enough to start at the University of West Virginia.

He had two years of chemical engineering before lightning knocked old mountaineer Jones out of a cherry tree and forced his son to come home. There wasn't much farming to do, so Raphael got going on an idea that had been banging around in his head for a couple of years—to build a power plant.

He was a little shy on money, so his brother-in-law got him the discarded galvanized hot-water tank which became his boiler, 12-in. dia. by 5-ft. by $\frac{3}{16}$-in. thick. He set four 4 x 4-in. locust posts 2 ft. in the ground, and $3\frac{1}{2}$ ft. above the ground put up two 4 x 4-in. locust cross-suspension beams. Two clothesline wires twisted together acted as hangers for his boiler. He put the brazed longitudinal seam down, in direct contact with the flames.

Mud Setting

Stone and mud from the creek bed form the boiler setting, the top of an old cookstove serving as the boiler front. There is no water column, no water glass, no gage cocks, no blow-off line, injector or feed pump. The only way to feed water is to close down and let the boiler cool. How does he tell what his water level is? Easy—when steam stops coming to the engine he knows the boiler is dry. That takes about five hours, then he "calls it a day." He does have an old steam gage, however, and with that ran an 85-lb. hydrostatic test. Fuel is wood, brought up by wheelbarrow.

Steam and safety valve lines (oh yes, he has a safety valve!) openings are the usual pipe connections on the side of the boiler opposite the seam. The steam line is bushed down to $\frac{1}{2}$ in. The safety valve $\frac{1}{2}$-in. line is also used to fill the boiler. A 10-gal. lard pail on the roof, Fig. 1, has a hose leading from it which is simply slipped over a tee in the safety valve line, and the water runs in by gravity.

The safety valve is a $\frac{3}{8}$-in. reducer, $\frac{1}{4}$-in. nipple and 2-in. long $\frac{1}{8}$-in. nipple at the top of a 3-ft. pipe. The end of the nipple is hollowed out with a drill so that an old musket ball fits into it. The musket ball is drilled for an 8-penny nail as a guide, the 8-penny nail fastened into a wooden lever arm, and the whole arrangement set up as in Fig. 3. A horseshoe is adjusted on the arm so the valve pops at 80 lb. (more or less).

When questioned regarding the possibility of a shifting setting, a burned-through support wire, or a red-hot bare plate, Raphael blandly explains that he always works nearby, so can put the fire out if trouble starts.

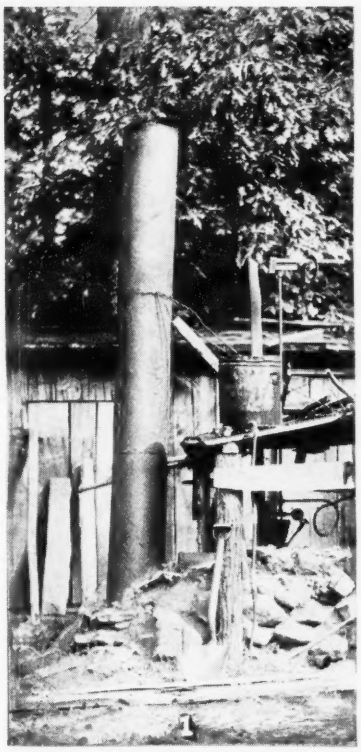
Well, that disposes of the boiler. Now for the engine. Two 8 x 8 x 5-ft. timbers were laid on the ground parallel and about 3 ft. from the boiler. Four 2 x 4 x 24-in. tie pieces complete the foundation and bedplate.

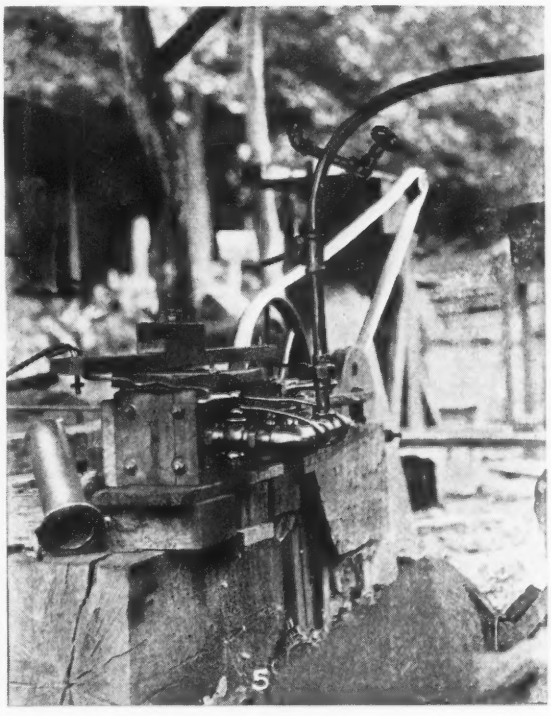
The 2 x 10-in. brass cylinder comes from an old spray pump. Heads are 2 x 5 x 5-in. wood bored partway through, then partly filled with babbitt metal for a seal. Four $\frac{3}{8}$-in. tie bolts hold the heads on. A $\frac{1}{2}$-in. hole is cut through the side of each head to take a $\frac{1}{2}$-in. nipple. On these nipples are screwed $\frac{1}{2}$-in. cold-water stop cocks piped together and to the steam supply line. Holes drilled in the sides of the stopcock bodies act as exhaust ports, and the handles are drilled for $\frac{3}{16}$-in. rods leading to a wooden rocker arm atop the cylinder. The steam valve pipes wouldn't hold, so long $\frac{3}{8}$-in. bolts were bent around them and pulled into a block on the other side of the cylinder, Fig. 5. The whole contraption was then bolted down to the bedplate with bolts through a board on top.

Gravity Lubrication

Cylinder lubrication? Easy! A piece of $\frac{3}{8}$-in. pipe with a valve in the middle and an ell at one end is screwed into the steam pipe. The short end of pipe is filled, plugged, and then the valve is opened so that the oil runs in by gravity.

The main shaft is $\frac{5}{8}$-in. cold-rolled steel in wooden bearings with a combination flywheel and pulley wheel in the center that formerly did duty on a wheelbarrow. On one end is a 4-in. wooden disk which operates a $\frac{3}{8}$-in. shaft that in turn operates the 90-deg., 6 x 6 x 2 x $\frac{1}{2}$-in. wooden rocker. On the other end of the shaft is an 8-in. wooden disk carrying a $\frac{1}{2}$-in. bolt through it for a crankpin. All wheels are babbitted in place. An automobile piston brass bushing set in the wooden connecting rod acts as a crankpin bearing. The crosshead is two wooden blocks with wooden gibs at the sides. The $\frac{1}{2}$-in. piston rod is about 12-in. long and ends in a babbitt disk for a piston. Grooves in it were first fitted with steam packing, but that didn't work so well,





so babbitt rings were substituted. The packing gland is wood, held on with wood screws.

So there we have our power plant. A belt from the 8-in. disk drives the grist mill that makes the family's corn meal. This only gives 150-r.p.m. so another belt runs from the wheelbarrow wheel at 250 r.p.m. to drive a homemade circular saw, wood lathe, emery wheel and grindstone.

The "riggin" works, so its ingenious creater has never worried about what might happen. Maybe that's the advantage of a college education.

Photographs and data abstracted from a report of an inspector for the Hartford Steam Boiler Inspection & Insurance Co., and used with permission.

Fig. 1—15-ft. stack of homemade boiler. On the roof of the boiler shed is a 10-gal. can used to feed water to the boiler by gravity

Fig. 2—Front of the boiler, fashioned from the top of a cook stove

Fig. 3—The safety valve. $\frac{1}{2}$-in. pipe is used up to the reducer and $\frac{1}{8}$-in. pipe at the top. An old musket bullet was used for the valve disk

Fig. 4—The flywheel. Jones, Sr., is oiling the crosshead and guides. The wooden wheel in the foreground operates the valve mechanism.

Fig. 5—The engine. At left is a piece of brass pipe like that used for the cylinder

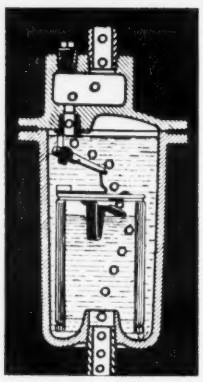
EVERY

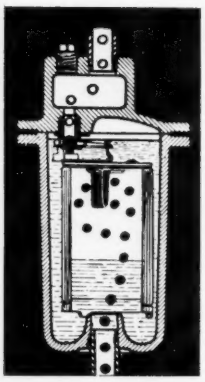
1ST
A STEAM
VALVE

2ND
A SWITCH
FOR *the* FAN

3rd
AN
ARMSTRONG
TRAP

(Right) With the trap cold, the bucket is down and both the discharge valve and the thermic vents are wide open. Air passes through without restriction.





(Left) When steam enters the trap, the heat bends the thermic strip, closing the vent, and the steam floats the bucket, closing the discharge valve.

UNIT HEATER Needs

THIS 3rd CONTROL

A VALVE to control the admission of steam and a switch to control the operation of the fan are prime essentials in a satisfactory unit heater. But the rapid condensation of steam that takes place in these heaters creates another need—for an efficient, automatic trap to control the removal of water and air from the radiation space without loss of steam.

An Armstrong trap meets this need exactly. It's the original inverted bucket trap—the type now rapidly becoming universal for industrial use. It embodies the improvements developed during a generation of leadership in trap design and manufacture. Its free-floating valve lever mechanism insures practically frictionless operation. Many years of trouble-free service is the common experience of Armstrong trap users.

Armstrong traps excel not only in handling a large volume of condensate dependably but are also unique in their air handling capacity. The automatic air bypass which can be supplied in any Armstrong trap makes it really a "blast" trap. This advantage is obvious when sudden changes in outside temperature call for quick heating results. The cold heater is filled with air, all of which must be removed before steam can fill the radiating space.

The Armstrong trap line includes sizes for all unit heater needs. Ask for the Armstrong Steam Trap book giving complete data on selection of traps for this and all the other standard uses for traps.

ARMSTRONG MACHINE WORKS

812 Maple Street, Three Rivers, Michigan

Avoid These Common Causes of Trouble

In applying steam traps to unit heaters, it is possible to make mistakes which lead to trouble. Some can be corrected by selecting the right trap, others by using the right hook-up. It pays to study the principles of condensate removal and to avail yourself of the help freely offered by Armstrong representatives and in the Armstrong Steam Trap handbook.

Probably the most common source of trouble is trying to drain two heaters with one trap. This invariably invites short circuiting trouble. The unfortunate thing about short circuiting is that it may cut down on the performance gradually so that the change is not immediately noticeable. Individual trapping is the sure way to stop it.

Airbinding is another source of trouble which can be eliminated by Armstrong traps. After having seen an Armstrong trap connected to a unit heater, some people jump at the conclusion that any trap can be used in the same way. They forget that Armstrong traps remove entrained air automatically; whereas, air relief valves may be needed to help traps that do not have this feature.

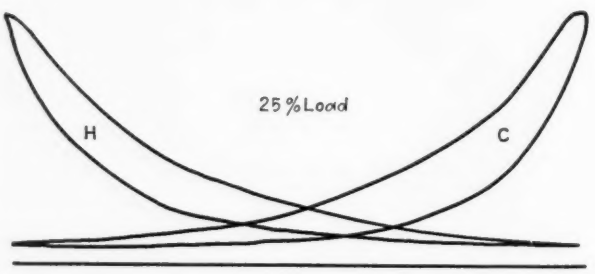
A less common cause for trouble arises when a unit heater is connected direct to a long steam supply header. In such cases, water collecting in the header itself is forced to pass through the heater where it may cause water hammering and leakage to say nothing of cutting down heating capacity. Prevention is simple—just put a trap on the end of the header and take the water out before it can get into the heater.

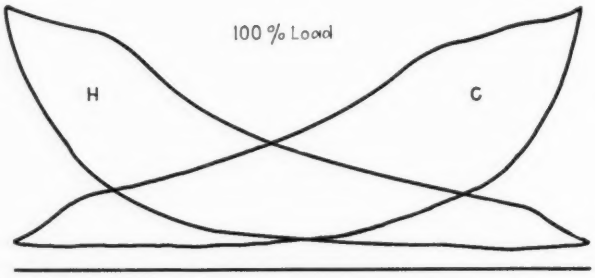
Undersize traps can also be a nuisance. Because unit heaters are compact, it is easy to underestimate their capacity. Remember that a small heater weighing only 150 pounds is often equivalent to as much as 4000 pounds of cast iron radiators. The Armstrong Machine Works and representatives have tables listing steam consumption data on practically all makes of unit heaters, and the trap sizes needed to handle the resulting condensate satisfactorily.

Ask for list of recommended sizes

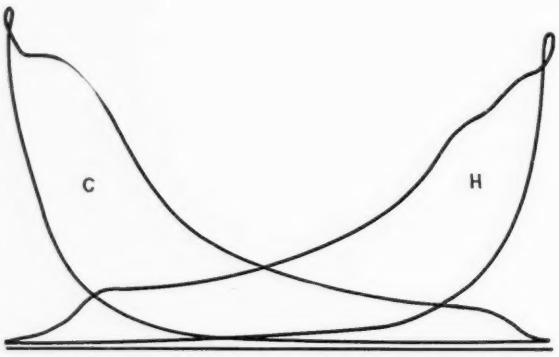
Number 36

Indicator Diagrams—Uniflow Steam Engine

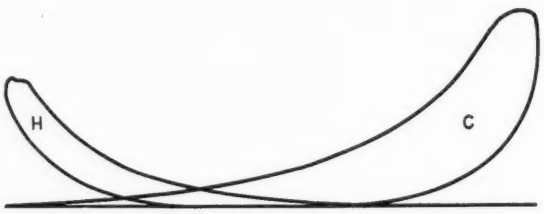




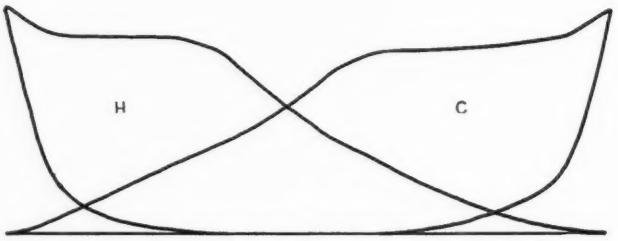
CORRECT DIAGRAMS



EXCESSIVE COMPRESSION. AUXILIARY EXHAUST VALVES CLOSE TOO EARLY



UNEQUAL CUT-OFF



EXCESSIVE COMPRESSION DUE TO HIGH BACK PRESSURE

LATE ADMISSION ON HEAD END

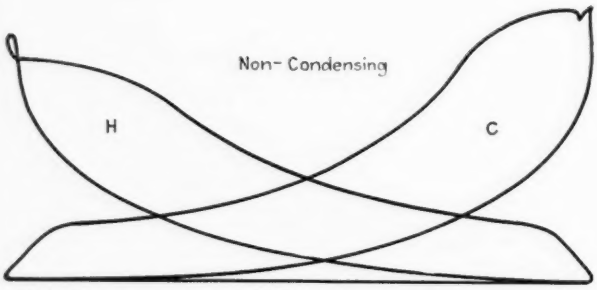
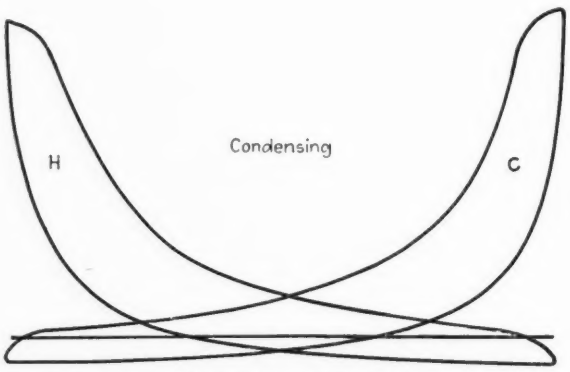


DIAGRAM SHOWS LATE ADMISSION ON THE CRANK END AND VERY LATE ON THE HEAD END



CORRECT CONDENSING DIAGRAM

Diagrams courtesy Elliott Co.

© POWER

PRACTICAL AIDS TO OPERATION

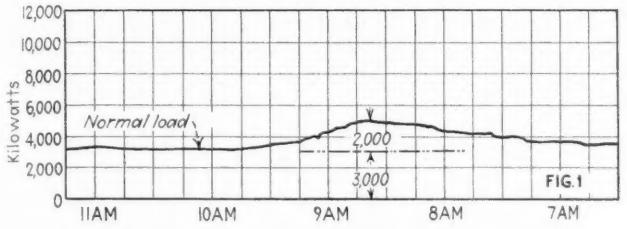


FIG. 1

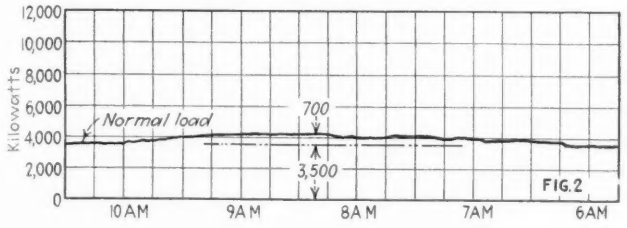


FIG. 2

Weather Conditions Increase Load 66%

ON SATURDAY morning, Feb. 23, White Rapids hydro-electric plant of Northern Electric Co. reported an output of 5,000 kw. This plant furnished power for operation of the Northern Paper Mills at Green Bay, Wis., over a 3-phase, 132,000-volt, 60-cycle line, 81 mi. long. Northern Paper Mills, however, was using approximately 3,000 kw., which indicated a loss of 40%. Checks were made of the instruments. The units were changed at White Rapids, a spare unit placed in service, with the same results. The amount of water being used through the wheels was calculated and found correct for the power output. All equipment appeared to be in good shape, both at the generating end and at the mill.

The power loss continued until about 8:30 a.m., when the output at the hydro-electric plant began to drop off gradually, and reached normal at 9:30 a.m. The extreme power loss was undoubtedly due to hoarfrost which covered every exposed wire and tree with a heavy, sharp crystalline coating. This frost on the line wires, together with the atmospheric conditions, undoubtedly caused a corona loss. The line loss just mentioned is the maximum in our nine years of experience, and is shown on the recording kilowatt meter reading, Fig. 1.

Records of the weather conditions were obtained from the U. S. Weather Bureau office at Green Bay. These indicated very high humidity with rather low temperatures. It is a little difficult to understand from this record, however, why no appreciable loss occurred before 7:30 a.m.

The following Saturday morning, Mar. 2, trees, wires and exposed surfaces were again coated with frost. The recording kilowatt-meter record, Fig. 2, shows the time the loss occurred and indicates that it was not as great as on the previous date. The Weather Bureau recorded 100% relative humidity with somewhat higher temperatures.

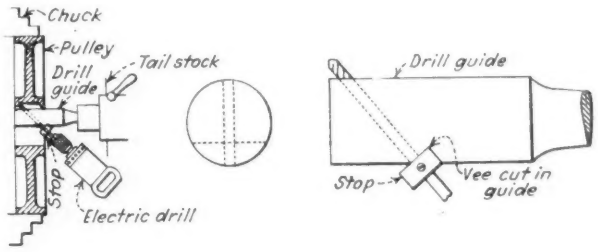
Our experience was passed on to the local utility engineers, and they reported that they had found a loss of 30% on one of their lines leading to a distant town located in a westerly direction. Normally, a utility is so inter-connected that it is difficult to notice losses of this kind at the time they occur. Northern Electric Co. has the advantage of being able to note such occurrences. Power consumption at Green Bay is relatively constant and we are continually in contact with the hydro-electric plant through our carrier-current telephone.

Green Bay, Wis. H. W. GOUCHNAUER
General Manager,
Northern Electric Co.

Drilling Oil Grooves in a Lathe

A NEAT way to cut oil grooves in loose pulleys after they are bored in the lathe is to use an electric drill and guide as shown in the drawing. The guide is made from round steel turned to fit the tailstock, with a diagonal hole near the front end. A vee is cut at the end of the hole to provide a surface for a stop collar used on the drill.

After the hole is bored, the tailstock is moved over to the rear to bring the guide close to the pulley bore. The drill is then inserted in the guide and the stop collar set to allow the drill to protrude enough to cut the groove. Commencing at the front of the bore, the electric drill is started and fed in until the stop touches the face of the vee cut in the guide. Then the tailstock is operated to move the drill slowly forward to cut the groove. The guide will



suit many sizes of pulleys, and when there are several to have oil grooves cut at the same time it is a time saver.

Spiral grooves can also be cut with the aid of the guide by turning the headstock as the tailstock is advanced. In this case, using the body, pressure is put on the electric drill to hold the stop in contact with the vee cut in the guide.

Hamilton, Ont. FRANK MOORE

Provide Access Doors For Slag Removal

TO INSURE trouble-free operation of bare-tube water walls in pulverized-fuel-fired furnaces, sufficient slag-removal access doors must be provided. These doors should be located so that all parts of the tube surfaces can be reached with rods or lances while the boiler is in service. Unless such openings are provided, and slag formation controlled, serious difficulties may be experienced.

Furnace water-wall surfaces exposed to direct heat of the furnace work at higher heat-absorption rates than the average heating surfaces of the boiler proper. The severity of this service renders highly important the internal and external cleanliness of these surfaces.

Internal cleanliness of tube surfaces can be controlled by

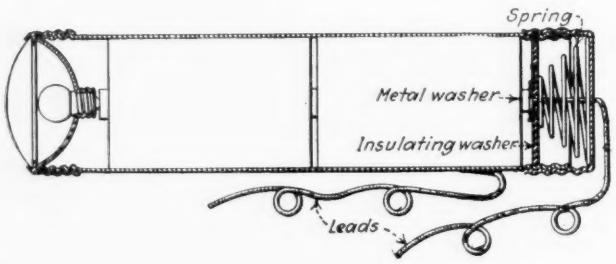
proper water treatment or frequent turbining. External cleanliness, the absence of slag formation, while subject to control by fuel selection and firing procedure, generally requires physical means of removing accumulations of ash and slag, which are almost invariably present.

When water-wall tubes are partially covered with slag, heat absorption is decreased and water circulation through the tubes impaired. Clean portions of tubes exposed to direct furnace heat, and absorbing this heat at a high rate, may become steam bound and overheated.

Excessive slag accumulations tend to increase the temperature of the gases leaving the furnace, and thus decrease overall boiler efficiency. This increase in gas temperature entering the boiler and superheater often causes final steam temperatures that exceed design limits. Heat reflected from incandescent masses of slag on water walls may also cause ash-pit difficulties, especially in furnaces not designed for slag-tap ash removal. The weight of heavy slag formations often represents an actual physical danger to the furnace. In one instance, a large mass of slag falling from the upper part of the furnace seriously damaged the ash-pit water-screen tubes, on which it fell, necessitating removal of the boiler from service.

Occasionally where access doors for continuous slag removal while the boiler is under load are not installed, or if installed, are improperly located, outage of the boiler unit is necessary for slag removal. In addition to the cost of boiler outage, the removal of large masses of cold material from the upper parts of water walls by men working in the furnace is a very hazardous undertaking and has resulted in serious accidents.

Waynesboro, Va. S. H. COLEMAN



Make Flash Light Into Test Lamp

I HAVE used a battery flash light for test purposes and find it very convenient. As in the figure, an insulating washer is placed between the spring and battery. A test lead is taken in through a hole in the cap and held in place by a metal washer used to make contact with the battery. A second lead is attached to the battery case, and the light circuit is completed by bringing together the free ends of the two leads. The lamp can be used both as a flash light and for test purposes.

Bloomfield, N. J. H. G. STODDARD

Key Unbalances Speed Reducer

WHILE testing a turbine with a built-in speed reducer, we noted that the machine vibrated quite perceptibly. This was due to some unbalanced condition, since the higher the speed, the greater the vibration. Investigation showed vibration in the speed reducer, probably due to unbalance in the larger gear. This gear has a pitch diameter of 20 in., a 5-in. face and a $3\frac{1}{4}$-in. bore with a $\frac{3}{4}$-in. by $\frac{3}{8}$-in. keyway and weighs over 200 lb.

The gear was removed from the unit, placed on the arbor of a balancing machine and appeared to be in nearly perfect balance. After considerable study, one of our engineers suggested that a key be made to fill the open keyway in the gear. When this was done the gear was out of balance. After the gear with the key in place was balanced and placed in the speed reducer, all vibration disappeared.

A little computation will show that a $\frac{3}{4}$ x $\frac{3}{8}$ x 5-in. key on a $3\frac{1}{4}$-in. shaft rotating at 400 r.p.m. will produce sufficient centrifugal force, if unbalanced, to cause the vibration originally found during the test.

Worcester, Mass. DAVID FLIEGELMAN
Coppus Engineering Co.

Use of Transformer Reactors

AT A recent plant operators' conference someone asked why reactors were installed in one of three transformer banks at an important substation served by a large power system. The installation consisted of six transformers, arranged in one reactor-equipped bank of two 1,000-kva. units, one bank of two 1,000-kva. units without reactors, and one with two 2,000-kva. units without reactors.

These reactors were installed to increase the impedance of transformers so that they would share the load in proportion to their rating when operating in parallel with the other banks. The latter do not require reactors, as their impedances are of the proper value to cause them to share the load in proportion to their ratings.

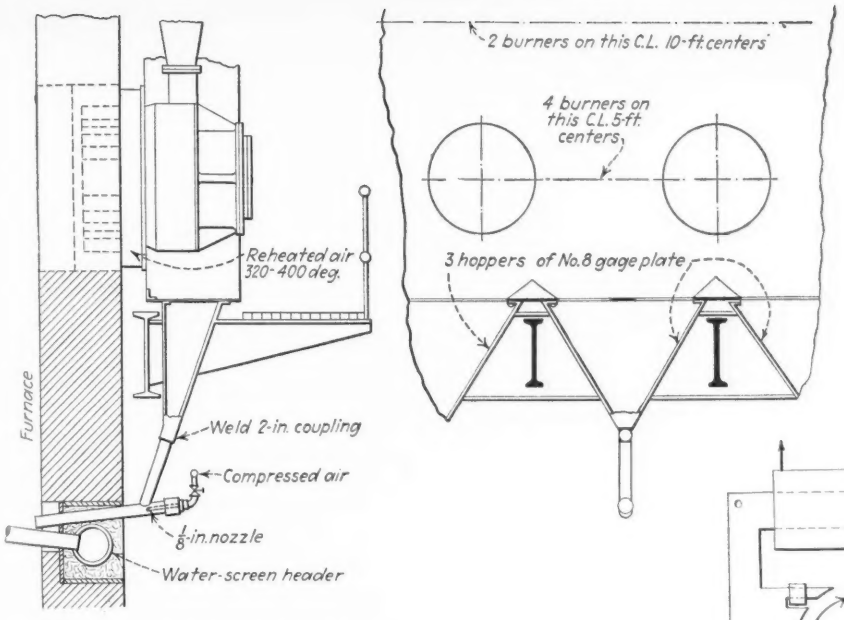
When transformers are operated in parallel, the load currents will divide among them in inverse proportion to their impedance drops. If the transformers are of different kva. ratings, it is necessary to reduce the impedance to a common kva. base before making the comparison. The impedance drop in a transformer is the number of volts required to force the full-load current through one of its windings with the other winding short-circuited and is equal to the current in amperes times the impedance in ohms. It is usually expressed as a percentage of the normal voltage. The impedance volts is the vector sum of the resistance volts and the reactance volts.

Boston, Mass. H. S. KNOWLTON

Keep Burner Boxes Free of Pulverized Coal

ON LARGE pulverized coal-fired boilers, often a number of burners are located within a forced-draft front which confines and controls secondary air under pressure to the furnace. Secondary-air pressure is usually controlled at the forced-draft fan. It is generally desirable to hold the secondary air-pressure in the burner box constant. This is not always practical, however, especially if boiler load varies over a wide range.

On one installation with six burners in a common forced-draft air chamber, forced-draft air pressure had to be reduced to about 1 in. of water on light loads, to prevent excessive air leakage through the vanes of burners not in operation.

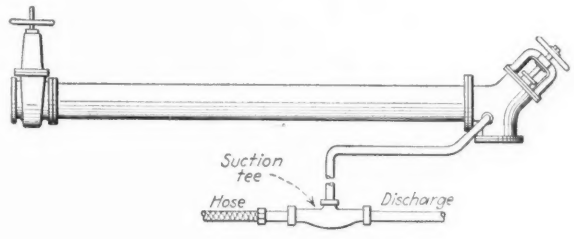


This pressure being considerably less than that from the mill permitted pulverized coal to fall through the vanes and gradually collect under them in the burner-box bottom. Radiation from the burner would ignite the coal and cause warping of the secondary-air vanes, which further aggravated the trouble.

After considerable experimenting with compressor air jet to clear the burner boxes of coal, it was decided to install hoppers on their bottoms, as in the figure. These hoppers were made to the same general shape, varying only in length to fit between supporting trusses. All four sides of each hopper were welded at the bottom to a 2-in. pipe coupling. From the bottom of each hopper a 2-in. pipe led through the front furnace wall just about the water-screen header, the pipe being inclined as much as possible.

Normally, air velocity through the pipe is sufficient to carry the siftings along into the furnace, but occasionally during light load when the draft pressure is low, coal settles in the pipe. This is readily cleared by opening a 1-in. compressed air jet in each pipe for a few minutes. These hoppers were installed about 18 months ago and have eliminated fires in the burner boxes and other troubles.

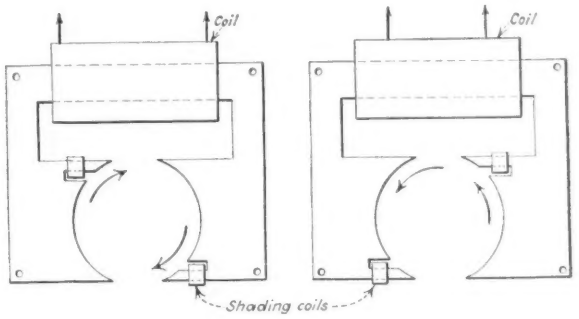
Winnipeg, Man. C. L. ALEXANDER



Uses Water Ejector When Packing a Valve

A GASKET under the bonnet of the non-return valve on one of our boilers had to be replaced. As the gate valve next to the header leaked, it was impossible to remove the bonnet without the risk of being burned. The header drain connected into the non-return valve, as in the figure, so we decided to try to create a vacuum in the header between the two valves. I put a suction tee in the drain line as shown and connected the city water hose to the water inlet and allowed the water to run. When the bonnet was removed, a sudden inrush of air showed a vacuum had been created in the steam pipe. The gasket was replaced without any inconvenience from steam. Air going in through the opening in the valve carried the steam along with it. The outlet pipe on the tee was made as long as possible, in this case about 15 ft.

Cleveland, O. THOMAS C. BROCK



Shaded-Pole Type Motor Reversed

ROTATION of a shaded-pole single-phase motor is in the direction that the shading coils are displaced from the pole axis, as shown in the diagrams. When dismantling these motors for repair, take care to note how the field core is placed in the frame. If this is not done the core may be put in the frame backward. If this is done the motor will reverse its direction of rotation as indicated in the figures.

Montreal, Que. J. E. WRIGHT

Advantages of Using High-Side Ammeters

AT A recent operating conference the reason was asked why ammeters had been installed in three transformer high-potential leads at an important distributing substation instead of in the low side. It was brought out that the transformers are step-down units, and that the high-side ammeters measure all the current input to the bank, including losses. As the transformers are rated at 11 kv. on the high side and 2,300 volts on the low side, the ratio being approximately 5 to 1, it would be necessary to have five times as many amperes to plot on a scale if ammeters were put in the low side. Thus, a 1,000-kva. transformer would require an ammeter reading 100 amp. full scale to allow for some overload, while the low side would require an ammeter reading 500 amp. full scale. The length of the scales would be the same in either case.

With the same number of scale divisions in either case, say 20 divisions, the high-side ammeter would read 5 amp. per division and the low-side ammeter 25 amp. per division. Therefore the high-side ammeter scale would be more legible and could be read more accurately. Each feeder at the substation has an ammeter on the outgoing 2,300-volt circuit, so that total low-side current can readily be obtained.

Boston, Mass. H. S. KNOWLTON

CURRENT COMMENT

Should Engineers Have Federal Licenses?

THE popular mind weaves romance around the achievements of the structural, electrical and chemical engineer. The operating engineer, whose work is just as important if less spectacular, is generally lost in the shuffle. To my mind federal licensing would definitely improve the standing of the operating engineer.

In the past the oiler who learned to set valves, make minor repairs, and possibly studied a little, applied for and generally received a license. Was he then an engineer? Examining boards were made up of men like himself; in their appointments political connections counted more than engineering knowledge. Examinations were unintelligent; combustion, for example, was in most cases completely overlooked. Necessarily, many licensees were unfitted for their jobs.

Equally unfortunate was the local nature of the license. If the engineer wanted to move afield he had to get a new license and, to get it, live for a while in the new locality and work there as an oiler or fireman. The college graduate wanted to be something better than "just an operating engineer."

Things like this tended to class the operating engineer as a skilled laborer rather than as a respected member of a dignified profession. And all types of engineers have suffered by this public view. Yet, to my mind, engineering is a profession, not a trade. A real engineer must be a business man.

As a practical step, I would suggest the federal licensing of all engineers, licenses to be graded and classed according to the several branches of engineering. Merely as a suggestion, I would like to ask how the following sounds:

Third-class license: Entitles holder to take charge, as operating engineer only, of any power plant up to a predetermined horsepower.

Second-class license: Entitles holder to take charge, as operating engineer only, of any power plant of any size.

First-class license: Entitles holder to take charge, as operating engineer only, of any steam-power plant, unlimited horsepower, and to take care as chief engineer of power plants up to a predetermined horsepower, and to act as assistant to the chief engineer of any power plant, unlimited horsepower.

Chief engineer's license: Entitles holder to take charge in any capacity of any power plant, unlimited horsepower.

Each of these licenses should provide for the examiners to report the ability of the holder in the various branches of the profession, such as refrigeration, air-conditioning, diesel engines, etc.

Now, of course, this outline is not a carefully studied proposal; it is merely a suggestion. But I do feel that all engineers should be licensed by the federal government, and that these licenses should entitle them to act in a given capacity anywhere in the United States or its possessions. The exact wording, etc., is a matter for such a body as the A.S.M.E. to decide.

Irrespective of how or where an engineer received his training, the final mark of his ability would be his license. This would be true whether he had been trained in a correspondence school or in a university. I would advocate examinations designed to bring out the applicant's knowledge of all the subjects taught in mechanical engineering in the university. On the other hand, practical experience should not be disregarded. There must be some way to give a fair break both to the self-trained practical man and the college-trained man. What do other *Power* readers think about this?

St. Louis, Mo. CHESTER G. ROBINSON

[*Power* is glad to publish Mr. Robinson's thought-provoking letter, and hopes it will bring in some worth-while discussion. This problem, however, may not be so easy to solve as might appear at first. For one little thing, how about constitutionality? Is it possible for the federal government to license engineers? We don't know; we're not lawyers, but just raise the question as a sample of the many things that must be considered. Again, it seems unlikely that operating engineers will get far in this matter of licensing unless they study the licensing activities of the professional engineers who have now gotten laws on the statute books of many states. Here, then, is a vital problem, but a tough one. What have other *Power* readers to offer in the way of comment and practical suggestions?—*Editor.*]

Formula for Diameter of a Circle

I WISH to call your attention to an error in Paul Bruhl's article on "Tools for Measuring Circular Sections," July number, page 379. The correct formula, using his notation, is:

$$\text{Diameter} = \left(\frac{1}{2}C\right)^2 \times \frac{1}{h} + h$$

Of course, when h is 1 in., as in his case, the formula is as he has given it, since the fraction $1/h$ equals 1.

Incidentally, the greater the ratio of C to h, the greater the error in the calculated value of the diameter. In the numerical example given, an error of 0.001 in. in the value of C will give an error in the diameter of 0.002 in.

Athens, Pa. H. C. CURTISS

Bonus or Prize System Is Advantageous

THE bonus system used by N. T. Pef and described by him in the May number is interesting but I wholeheartedly agree with the comments of J. O'Brien in the July number.

The remuneration was niggardly in the extreme and it speaks volumes for the *esprit de corps* of the men that they continued to give good results when their efforts were so little appreciated.

As between the bonus system and that of raising the weekly pay, the former is liable to give better results. A pay rise, once granted, is difficult to change should the man's efforts slacken or business conditions entail a reduction. A bonus is more flexible and conducive of far greater efforts.

Many readers will remember the old coal-firing days of the trans-Atlantic Ferry. The watch reviving the greatest number on the crossing was rewarded with bottles of whisky. It used to bring forth the highest spirit of cooperation and

every man, from watch engineer to lowest coal passer, was keen and eager. The reading of the counter was a serious business and every man was below in good time to see that the beginning of his watch found everything in perfect order.

Firemen were keenly critical of the condition of their fires when taking over, and the coal passers were alert as to the supply left them.

In shore plants, where constant repetition of regular duties seven days a week tends to become monotonous, it is imperative that some method be used to keep the men on their toes. The bonus system is admirable for this and it entails only a little thought and effort on the part of the supervisory staff to install it.

It can be in the form of a monthly prize to the shift showing the most economical all-around operation as regards evaporation, coal, oil, etc. This, if adequate charts and meters are used, is quite feasible. It will promote a keen spirit of competition.

A form of monthly bonus may be used so that everyone may benefit and it can be based on the saving in power plant operation costs over that of a given average month. In this last method all expenses must be taken into account; packing, paint, etc.—in fact, all supplies of every kind.

The prize system is far better in results. When one shift is pitted against another there is more chance of definite action and the engineer is better able to weed out the slackers than if the operating crew benefits as a whole.

Amongst sales forces, the competitive spirit is fostered and kept alive, with beneficial results to both company and employees.

The same methods should be initiated to suit the requirements of the power house, because these operators are just as important to the company as the salesmen, and any economy they effect will show, eventually, in the decreased cost and consequent larger volume of sales of the product manufactured.

Passaic, N. J. MARK BELL

Dispersed Organic Colloids Help in Feedwater Deaeration

IN "Chemical Deaeration of Boiler Feedwater" in June *Power* Sheppard T. Powell states:

"A common ingredient in boiler compounds is often designated as 'organic colloids'—a term covering several hundred thousand chemical compounds, since 'organic' only specifies carbon compounds and suggests animal or vegetable origin, while 'colloid' refers to a state of dispersion. Most of these substances which have been found to have real merit in boiler water treatment belong to two large groups of compounds—starches and tannins."

While Mr. Powell's first statement is perfectly true, he has overlooked entirely those type colloids which have proven the most beneficial in water conditioning. I refer to a truly dispersed colloid of organic origin possessing a definite chemical reaction with calcium and magnesium salts, which reaction results in a transpostition of the colloid from a sol to a gel state. Neither starches nor tannin possess any such reaction and we therefore differ with the author in his statement that most of the colloids shown to possess true merit fall under the groupings he mentions.

Colloids of the type to which I refer are extracts from subaqueous growths. Complexity of their chemical structure does not permit their true chemical designation. Some refer to them as belonging to the alginate grouping, but such is not true, for alginates possess no reaction with magnesium. (1) Others prefer to class them as belonging to the laminaric acid grouping. (2) Until further work is completed, we remain with an open mind as to their exact chemical grouping. Suffice it to say that their combining weights of chemical reaction are known. Colloids, by the very nature of their structure, do not react on a stoichiometric basis, hence these combining weights do not reflect true molecular weights and will also vary according to the composition of the water.

Starch, referred to in Mr. Powell's article, was used but very little until the results were published of the experiments conducted at The U. S. Naval Experimental Station (3) and its true value has been a subject of considerable question. (4) From the report of Adams however, (5) no ill effects have been noted from the possible hydrolysis of starch into sugar.

I had the privilege of assisting in one part of the experiments of the U. S. Naval Station and recall very distinctly asking Lt. Com. Solberg if the introduction of starch was for its colloidal action in preventing crystalline growths of scale. I received the answer that such was not the intention. In one of the experiments, foaming was noted in the experimental boiler which happened to subside on the addition of starch. Further experiments convinced them this product was of value in this respect and was the reason for its adoption.

The ability of tannin to absorb oxygen was known as early as 1918 and was referred to by Cushman and Gardner (6). French also referred to this property of tannin in 1923 (7) and again in 1934 (8).

Philadelphia, Pa. L. D. BETZ

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(2)—Private communication from a foreign source.
(3)—T. A. Solberg and R. C. Adams, Jr. Combustion Vol. 5—No. 6—pages 24-32, December, 1933.
(4)—R. E. Hall—Combustion—Vol. 5 No. 7. December, 1934—page 32.
(5)—R. C. Adams, Jr., Combustion—Vol. 6, No. 6. December, 1934—page 37.
(6)—Cushman & Gardner "Corrosion and Preservation of Iron and Steel" 1st Edition. Iron Age Book Dept., N. Y. 1918—page 101.
(7)—D. K. French, Industrial & Engineering Chemistry 15, 1239 (1923)
(8)—D. K. French, ibid 26, 1332 (1934)

Suction Head on Pumps When Handling Hot Water

DELIVERING hot water to a pump under pressure as suggested in the May number will in a large measure insure its proper operation. Satisfactory operation, however, also depends upon layout of the pumping system. Hot water has a greater volume than cold, and for that reason it is advisable to use pipe about 10% larger for the former than is necessary for the latter. The pipe should be free from constricted areas and run as direct as possible.

Either centrifugal or reciprocating pumps designed for cold water should be operated at a somewhat lower speed when handling hot water. If a pump's speed is too high, low-pressure zones will form in it and cause steam binding. Hot water is always more difficult to pump than cold, and if the installation is not properly designed and installed, trouble may be encountered even if water is delivered under pressure to the pump.

Bromley, England W. E. WARNER

READERS' PROBLEMS

QUESTIONS for Our Readers

Diesel Exhaust Heat

Question 1

OUR ice plant was converted to diesel power this spring and ran 24 hr. a day through the summer. Recently load has dropped off, so that we are running only one shift now. My pyrometer now shows steadily rising exhaust temperatures through the day, while before they held steady. Load is nearly constant, according to my watt-hour meter. What is wrong?—F.F.S.

Immune Bacteria?

Question 2

WE HAVE *two condensing turbines developing 5,500 kw., and we take our circulating water from a river. The temperature of this river water ranges from 72 to 82 deg. during the summer, and up until three years ago, we had trouble from slime in the condenser tubes during the summer months. We had to clean the condenser tubes every two days, which greatly curtailed our output just when most needed.*

Three years ago I started to use chlorine, introducing it at the rate of 3½ lb. per million gal., at a point in the intake tunnel approx. 600 ft. from the condensers, and slime conditions were so improved that we could carry the turbines on the line two weeks before it became necessary to clean condensers, the amount of chlorine fed being gradually reduced to 2½ lb. per million gals. of water. Chlorine was used from July 1 until Sept. 20, 1933, and again started July 5, 1934. By Aug. 15, 1934, it was noticed that the chlorine treatment was not as effective as it was the first year, weekly condenser cleaning being necessary, and this is again true this year, although we have again increased the rate of chlorine fed to 4½ lb. per million gals. of water.

Our chemist tells me that the slime bacteria is probably becoming immune to the chlorine, and that I ought to alternate the chlorine treatment with ammonia to break down the bacteria resistance to chlorine, but I would like to hear some other opinions before it do this. Careful inspection of the condensers, after using chlorine two summers, showed no signs of corrosion.—A.H.W.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Single-phase Load on Three-phase System

WE ARE *having trouble with a small 3-phase power system being seriously unbalanced by a constant-current transformer supplying a street-lighting load. The power factor of the load is low, which makes it doubly objectionable. Can a transformer be obtained to supply a single-phase load from a 3-phase system? If this cannot be done, what is the best solution to the problem?*—W.F.H.

There is no way that transformers can be connected to supply a single-phase load from a 3-phase system and maintain the system balance. If your street lighting load is large enough, the best solution to the problem would be to divide it into at least two equal parts and put each of these parts on a transformer connected to two of the three phases. Better still would be to divide it into three parts and use three transformers, one connected to each phase. A 3-phase motor can be used to drive a single-phase generator, and this generator in turn to supply the constant-current transformer. This is going to a lot of expense and also decreases the reliability of the system. Another thing that you can do is install a static condenser on the arc-lighting circuit. This probably would be the best solution to the problem. Although it does not balance the system, it will bring the power factor of the street-lighting load to nearly unity.

STANDBY BOILER CORROSION

ANSWERS to July Question 1

The Question

TWO *of our old Stirling boilers, kept as standby units, may go for several months without being used. Nevertheless, we feel it necessary to keep these units filled with water so they will be more readily available. We have found that the alkalinity of the water decreases in the top drum and increases in the mud drum. This action makes the water in the top drum more corrosive. Have any Power readers experienced this condition? If so, I would appreciate learning what they did about it.*—A.K.

Remove Oxygen

IT IS a common occurrence that much damage, due to corrosion, is done to boilers during periods of brief shutdowns or standby service.

Theoretically, corrosion should stop completely when the pH value of the boiler water reaches 10.6 in practice. However, corrosion takes place in waters of a much higher hydrogen-ion concentration.

A.K. has not given enough data on the equipment in his plant and quality of his bolier water and, therefore, it is hard to suggest, not knowing the actual conditions.

The corrosion is probably due to air entering the boiler and dissolving rapidly in the water. The decrease in alkalinity is caused by condensation of the steam and entrainment of carbon dioxide.

To remedy this situation, it is advisable to fill the boiler to operating level and maintain a pH value of at least 10.6 by addition of soda ash or caustic soda if necessary. If sodium sulphite is used in the water treatment, the pump may be operated slowly after the boiler has been dropped just enough to balance the contraction of the boiler water and fill it completely when cold. If unable to comply with the above suggestion, a large dose of sodium sulphite should be added before taking the boiler off load. The water should be analyzed every few days for soluble sodium sulphite and pH, and if necessary adjusted to maintain the tolerated excess.

Removal of free oxygen through open-air heaters or deaerators, and maintenance of a proper alkalinity may reduce possibilities of corrosion.

There are at present numerous methods of chemical deaeration, some of them already antiquated, others in process of development.

Tannin reacts with the oxygen and thereby reduces the corrosive property of boiler water. Ferrous salts separate in alkaline boiler water, in the form of ferrous hydroxide, $Fe(OH)_2$, which quickly absorbs any oxygen present and becomes ferric hydroxide, $Fe(OH)_3$, which precipitates as sludge.

The most recommended and efficient of all is sodium sulphite, Na_2SO_3. About 0.139 lb. of commercial sodium sulphite per 1,000 gal. of feedwater is required for each c.c. of oxygen per liter of water. An excess of 30 p.p.m. of sodium sulphite is sufficient to protect the boiler from free oxygen. The sodium sulphite absorbs free oxygen and forms sodium sulphate which is soluble at any proportion and serves as an inhibitor to caustic embrittlement.

St. Louis, Mo. MARCUS COOK
Cahokia Power Plant

Use Blowdown from Other Boilers

IT WOULD seem advisable in A.K.'s. case to discharge the blowdown from his other boiler into his two Stirling standby units, thus

keeping his boiler warm. This arrangement would mean that they would be more readily available, and at the same time with the water being changed at all times and being replaced with blowdown water from the adjacent boiler, the corrosion problem should also be solved.

Boston, Mass. RAYMOND M. NEE

Keep Boiler Filled With Water

THE fact that the alkalinity increases in the mud drum and decreases in the first drum indicates that there is a problem in itself which should be thoroughly investigated. Assuming that the water was uniformly alkaline when placed in standby service, there is no obvious reason why the alkalinity should vary materially.

To prevent corrosion for the conditions described, I would recommend that the boiler be filled with water (deaerated water preferred) to the steam nozzles. The superheater tubes should be filled if the boiler is equipped with superheater. Precautions should be taken to stop all leaks to insure the boiler being kept completely filled at all times.

When filling the boiler, chemicals should be added to secure one of the following conditions in the boiler water.

(a) A minimum of 300 ppm. of excess sodium hydroxide (NaOH) in the boiler water.

(b) A minimum of 300 ppm. of excess sodium hydroxide (NaOH) and 30 ppm. of excess sodium sulphite (Na_2SO_3).

(c) A minimum of 300 ppm. of excess sodium hydroxide (NaOH) and 300 ppm. of excess sodium chromate (Na_2CrO_4).

It would be well to boil the water in the boiler for an hour or two with the air vents open, to drive off any gases which may be in the boiler water.

If any of these precautions are taken, no corrosion will occur while the boiler is in standby condition. Before the boiler is put back into active service, it should be blown down to secure the proper boiler-water level. During freezing weather precautions should be taken to prevent the water in the boiler from freezing and bursting the tubes.

Birmingham, Ala. J. R. HUNT

Four Ways to Inhibit Corrosion

FOR the purpose of minimizing or eliminating the corrosion in A.K.'s standby boilers, I suggest any one of the following expedients:

1. After the boiler is removed from the line and cooled, drain it and apply a coating of corrosive resistant paint, such as Apexior, to the tubes and drums. A regular tube cleaner with brush attachment will spread the paint smoothly and evenly on the tubes. The drums may be coated with the same paint applied with a painter's brush.

2. Completely fill the boiler with feedwater and inject sufficient sodium hydroxide to bring the alkalinity up to about 11 pH. Be sure that there is no air pocket in the top drum.

3. Use sodium sulphite to absorb the free oxygen in the water. Current articles by Sheppard T. Powell in *Power* will give you ample data and information on this method.

4. In the event that the plant includes a deaerating feedwater heater, fill the boiler with deaerated water and slowly drain it, adding the same quantity as drained with the feed pump. This will insure you against the possibility of reabsorbing air present in the steam space after the boiler is taken off the line. The quantity drained and made up should be slightly in excess of the total water capacity of the boiler.

In using any one of the last three suggestions it would be well to test the water in the boiler for free oxygen by the Winkler determination method. This test should be made as soon as the boiler is filled and the suggestion followed. As time passes, the free oxygen content will decrease, due to the deactivation of the water as a result of corrosion, hence it is necessary to make the test as soon as possible. (I mean at least a day or two after the boiler is shut down).

In writing of the Winkler method, the fact is called to mind that the accuracy of this oxygen determination is frequently questioned. This skepticism is due entirely to the fact that more than frequently samples are tested before they are cooled to a temperature where the reagents are sensitive and useful. Samples should be between 70 to 90 deg. F. before being tested. Deaerated water samples that show the absence of oxygen at 180 deg. F. usually show up to as much as 0.02 cc. per liter at 70 deg. F.

Los Angeles, Calif. WM. R. DUNN
Elliott Co.

Coat Boiler With Cement

THE problem of reducing corrosive action in standby boilers is not a new one. Circulation is sluggish in these idle boilers, which are necessarily kept with water level at operating height. Free oxygen and CO_2 remains in longer and more direct contact with bare metal surfaces, and pitting usually results.

There are some water treatments which are available for such conditions, and they work out very satisfactorily in many cases. These are chemical treatments and require periodic testing of the boiler water in order to proportion the treatment correctly.

One excellent method of retarding corrosive action in such boilers is to protect the internal surfaces with a corrosion-resistant coating. All internal surfaces should be dried and wire-brushed clean. There are commercial paints especially developed for this purpose that give protection to the metal.

An easily prepared protective coating is made by mixing plain Portland cement and water (no sand) to a consistency of cream. This mixture is then applied to the internal surfaces with a paintbrush. The cement wash coating has been used successfully in many boilers operating up to about 250 lb. per sq.in. as well as in standby service. It usually lasts about two years, when it may be brushed and a successive coating applied.

It is recommended that the boiler for standby service be filled with water up to the steam nozzles to reduce pitting of the shell along the water line. It should take but a few minutes to blow the boiler down to operating level before firing up, and this time is usually available.

Brookline, Mass. HARRY M. SPRING.

THE PROBLEM OF PIPELINE DRAINAGE

ANSWERS to July Question 2

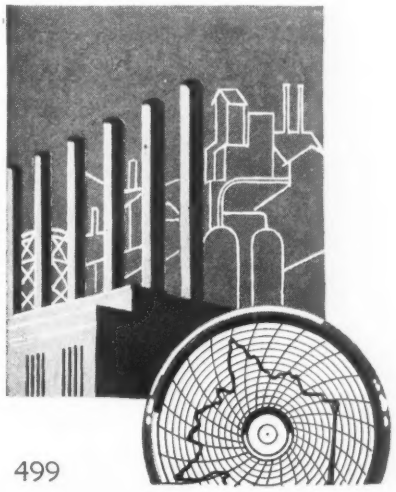
The Question

OUR *present boiler room at the north end of the manufacturing plant supplies saturated steam to a plant header which is sloped to drain at its far end. We are now building a new boiler house at the south end of the plant and will shut down the old boilers when it is finished. It is our intention to connect the new boilers to the plant header at its south end, but the question has been raised as to whether or not it will be necessary to regrade the header so it will drain in the direction of steam flow instead of against it when the new boilers go into operation. What troubles are likely to develop if the header is not changed, and can they be avoided without regrading (which will not be easy)?*—A.N.

Connect New Steam Line To Center of Header

GOOD engineering practice dictates that on high-pressure steam lines the steam and condensate shall flow in the same direction. However, exceptions to this rule can be made under certain favorable conditions, and when good judgment is used in its application. The purpose of avoiding counterflow of steam and water in steam pipes is to minimize the danger of water hammer.

Considering the problem at hand, I recommend that the new steam line be connected to the header at some other place than the south end, preferably about the middle of the header, either at the side or top. By this method the present drip connection at the



end of the header would remain undisturbed.

If this scheme is impractical, I suggest a liberal-sized drip pocket be installed close to the header. Drain all condensate to this point and provide a trap of sufficient capacity to dispose of the condensate. The drip pocket should have a free blow, so that the line could be drained when starting up after a shutdown.

With these precautions and the new steam line and header properly insulated, I believe the danger of encountering any serious trouble is avoided.

Fitchburg, Mass. E. W. SHAFER

Regrading Steam Header Not Necessary

IN VIEW of the probable expense and labor involved in relaying the steam main I believe that such a step is not necessary. Although good engineering practice and proper design would require the proper pitch of a steam main away from the boiler header, it might be possible in an exceptional case to provide proper drainage.

If the line is not properly drained, there is considerable danger from possible violent rupture by water hammer on opening the stop valve on the boiler.

A high-capacity drainer should be connected to the lowest point of the steam main near the boilers. Directly above this connection a short nipple, globe valve and vertical check valve are suggested. This should open to atmosphere, and during all times of operation and shut-down periods the globe valve should be left open. It only serves to shut off the line in case of failure of the check valve. This connection will serve as a vacuum breaker and prevent possible retarding of proper drainage. All possible pockets along the steam main should drain to trapped receivers. An open drain should be provided from the steam line just above the flange of the boiler stop valve.

Operating personnel should be educated in careful attention to warming up this steam main. The open drain should have its valve opened as soon as steam pressure has dropped on shutting down. It should never be closed until all condensation has blown out on starting up. A periodic inspection and maintenance program of all traps and drainers should be instituted.

Brookline, Mass. HARRY M. SPRING.

No Trouble if Velocity Is Below 5,000 f.p.m.

THE average moderately priced home with a steam heating system is full of pipes carrying steam and water in opposite directions. Because the pipes are large and the velocity of the steam and water is low, they pass each other without trouble. It is when the pipe is too small (which of course gives a higher velocity) that the familiar water hammer is heard in so many one-pipe steam-heating systems.

Nothing is said about the size or length of pipe nor of the quantity of steam passing through the plant header. Therefore, the first thing to check is the velocity of the steam flowing under maximum conditions. If the velocity should be low, say around 5,000 ft. per min., then with fair drainage conditions there should be no trouble with the header due to counterflow.

However if the velocity should be above 10,000 ft. per min., then more care will be required. Yet there is nothing to be alarmed at, for it is quite common practice in the installation of underground central-heating distribution mains to disregard the pitch of the steam main even when velocities go as high as 25,000 ft. per min. If the velocity exceeds say 10,000 ft. per min., then the drainage must be carefully attended to. First the drip traps should be sized amply to take care of slugs of water. Second, the drip piping to the trap should be sized amply. Some companies use nothing smaller than 2-in., others 1½-in. or smaller. Third, the takeoff at the header should be ample, say for a 10-in. main, a 6-in. drip pot 12 in. long should be installed with the drip piping connected to the drip pot.

Then the spacing of the drip traps must be considered. For velocities between 10,000 and 15,000 ft. per min., one trap for every 200 ft. of pipe should be sufficient, for higher velocities it might be advisable to install additional drip traps.

Yet one must not lose sight of the fact that the higher the velocity the less condensate to be drained from the steam mains, due to re-evaporation because of pressure drop.

In short I would not change the slope of the plant header unless it was woefully undersized, and then it should be replaced and not resloped.

Boston, Mass. RAYMOND M. NEE

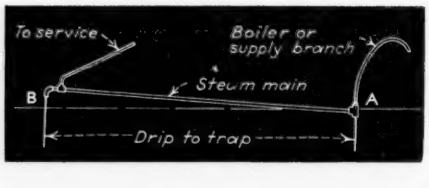
Hurricane Force

MOST of us who have had much experience in designing low-pressure heating systems have at some time or other drained large mains against the steam flow without experiencing any difficulty. In this case, of course, we have a very low velocity of steam flow. At the opposite end of the scale, we find ourselves dealing with high-pressure mains and high steam velocities, in some cases as high as 10,000 ft. per min. or more.

Such velocities are those of a hurricane, and the condensation will be carried along with the steam regardless of any pitch we may give to the main, moreover it is quite ridiculous to visualize the water of condensation as flowing quietly along the bottom of the pipe while it is being lashed by forces of a great storm.

The only thing which we are really interested in is getting the water out of the main as quickly as possible, and in avoiding water hammer. If we are successful in doing this, we should not have any trouble.

Looking at the sketch, we shall see that any water carried over from the boiler connection will tend to drain out at end *A*, and if the velocity of the steam is very low or zero, the main will also drain at that end.



When the velocity of the steam increases, the condensation will be carried along with it to the end *B* where we must be careful to avoid water hammer, but if the main ends in a reducing ell, so that the water is turned into a drip line without shock, we should not have any hammer.

Bloomfield, N. J. JAMES O. G. GIBBONS
Consulting Engineer.

Take Branches From Top of Header

WHILE it is undoubtedly best to have a steam header slope "with the flow", still it should not be necessary to go to the extra trouble of regrading the header. Just suppose that the old boiler room on the north end were not abandoned, but was left to function as a spare unit or stand-by, or perhaps to furnish more steam in case of an increased demand. Cases of this kind occur very often in actual practice. All that is necessary is to keep the header as dry as possible.

For the case in question, slope the connection from the new boiler house toward the south end of the steam header and there, at the low point, place a steam separator of the receiver type and provide it with a proper-sized steam trap. Keep the steam header well insulated to reduce condensation due to radiation to a minimum. All the off-takes from the main header should be taken from the top by means of a U-shaped pipe or goose-neck. In case of steam turbines or large reciprocating engines provided with fly-wheels, where dry steam is essential, provide an individual steam separator as close as possible to the steam inlet of each turbine or engine.

Pittsburgh, Pa. BERNARD KRAMER

Improved Generator Designs

Substantial increases in generator rating, accompanied by improvements in insulation designed to do away with corona losses, have been realized in the past five years, according to a recent address at Boston before a public utility group by M. D. Ross of Westinghouse. Ratings in units running 3,600 r.p.m have been increased from 18,750 kva. in 1929 to 25,000 kva. in recent quotations, and normal electrical characteristics have been retained. There is a field for these larger units in connection with 1,200-lb. outfits superimposed on existing stations. In the 1,800-r.p.m. class, designs have developed from 94,000 to 250,000 kva.

Mica-tape insulation has aided in getting rid of difficulties in bending. This is built up on the coils. Where coil length has increased beyond a certain limit, the mica-tape has been found useful in providing needed flexibility. New insulating products are coming on the market, and some use is being made of a so-called bonding material applied in liquid form. Good progress is being achieved in cutting down or eliminating corona through the use of increased air spaces and installation of a grounding sheath outside the coil. This does away with corona on the straight part of the coil.

THE ENGINEER'S BOOKSHELF

Fans

FANS (1935)—*By Theodore Baumeister, Jr., assistant professor of mechanical engineering, Columbia University. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 241 pages. 6x9 in. 78 diagrams. 24 tables. Price, $3.50.*

The purpose of this comprehensive treatise is to enable the user to select that type of fan which is best suited to his particular needs. While it contains some theoretical and design material, the book is in no sense a design text. Available equipment is described and illustrated and performance characteristics and uses given. Methods of selection and criteria are presented. Concluding chapters contain methods of testing and information on flow of fluids. First of its kind, it is a practical reference book of great value.

Motor Fuel

THE PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION, VOL. II *(Vol. 1 reviewed April, 1935, page 215)—By Alfred W. Nash, Professor of Petroleum Technology, University of Birmingham (Engand), and Donald A. Howes, Anglo-Persian Oil Co., Ltd. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 523 pages, 6x9¾ in. Cloth. 127 illustrations; 93 tables. Price $8 (Vol. 11).*

The second half of this authoritative work on internal-combustion engine fuels deals with properties, covering such subjects as analysis, sulphur contents, gumming properties, volatility requirements and knock ratings as well as motor and aviation fuel specifications. There is also a 40-page chapter on automotive diesel engines and diesel oils and a 24-page appendix including many valuable tables.

This reviewer is so impressed by the magnitude of the work that he hesitates to attempt a critical review. The work is formal and exhaustive, extensively annotated, complete and withal is quite readable.

Noise

NOISE—A COMPREHENSIVE SURVEY FROM EVERY POINT OF VIEW (1935)—*By Dr. N. V. McLachlan. Published by Oxford University Press, 114 Fifth Ave., New York, N. Y. 148 pages, 5x7¼ in. Cloth. 62 illustrations; 18 tables. Price $2.25.*

A comprehensive approach rather than a specialized treatment of this subject, which is growing so rapidly in importance (124 of the bibliographical references refer to articles written within the past 5 years!). The ten chapters include: General Considerations, Behavior of the Ear, Measurement of Noise, Frequency Analysis, Noise in Buildings, Traffic Noise, Train Noise, Noise Due to Machinery, Noise Due to Electrical Machines, Physiological and Psychological Effects of Noise. The appendix includes tables giving various noise levels and references. Power engineers will find of particular value the data and suggestions regarding noise in buildings and that from machinery and electrical equipment. The book is well written and authoritative.

Brief Reviews

SMOKE AND AVIATION (1935). *By H. B. Meller and L. B. Sisson, Mellon Institute of Industrial Reserach, Pittsburgh, Pa. Eight mimeographed pages. Free*—Report of a study on relations of urban smoke to aviation shows that smoke from industrial communities is retarding expansion of private flying. Remedies and precautionary measures are suggested.

INDUSTRIAL COAL-BURNING EQUIPMENT (1935). *Published by Appalachian Coals, Inc., Transportation Bldg., Cincinnati, Ohio. 19 pages. 27 tables. Paper.*—Analysis covering 7,284 plants, illustrates comparative importance of various types of coal-burning equipment used by industrial plants in eight states where large volumes of ACI coals are sold.

ILLINOIS PETROLEUM NO. 26 (1935). *By A. H. Bell. State Geological Survey, Urbana, Ill. Enclose postage of 1½ cents.*—Oil & Gas Development in Illinois in 1934. Statistical Summary. Reprinted from Transactions, A.I.M.E.

INDUSTRIAL MACHINERY IN PRINCIPAL COUNTRIES (1935). *Information Bulletin 825, Superintendent of Documents, Washington, D. C. Price, 10 cents.*—Pamphlet gives information concerning machinery production and trade in seven foreign countries.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE U. S. (1935). *Bulletin No. III-2. Published by National Bureau of Standards, U. S. Department of Commerce. 86 mimeographed pages. Paper cover.*

INTRODUCTION OF NEW INDUSTRIAL PRODUCTS (1935). *By O. C. Holleran of Marketing Research and Service Division, Bureau of Foreign & Domestic Commerce, Washington, D. C. 23 mimeographed pages. One chart. Price, 5 cents.*—Concise study gives in simple language essential factors that should be taken into consideration in bringing out new industrial products.

TURBINES, CONDENSERS AND FEEDWATER HEATERS (1935). *Report of the Turbine Subcommittee of the Prime Movers Committee, Edison Electric Institute. Publication No. C5. Published by the Institute, 420 Lexington Ave., New York, N. Y. Price, 40 cents to members and their employees. $1 to non-members.*—Contains statements by operating companies and manufacturers on turbine operating experiences, deposits on turbine blading, corrosion and erosion of turbine blading, turbine lubricating oil, test of 90,000-kw. generator, condenser operating experiences, condenser tube materials, chlorination of circulating water, circulating, condensate and boiler-feed pumps, feedwater heaters and deaeration.

BENDING OF WROUGHT IRON PLATES (1935). *Prepared by Engineering Service Dep't, A. M. Byers Co.; reprinted from Boiler Maker and Plate Fabricator. Paper, 12 pages, 8½ x 11 in. Free*—Principles and practice used in the design of structures employing bent wrought-iron plates.

A.S.T.M. (1935). *Four preprints of papers to be presented at 38th annual meeting. No. 32, Influence of Time on Creep of Steel; No. 45, Report of Committee C-8 on Refractories; No. 70, The Influence of Engine Design on Oil Consumption; No. 10, Report of Committee A-5 on Corrosion of Iron and Steel.*

KRAFTFAHRTECHNISCHES TASCHENBUCH *(Automotive Pocket Manual) Issued by the Robert Bosch A.G. 192 pages, 4x5½ in. ¼-in. thick. Distributed by VDI-Verlag, Berlin, N.W. 7. Price, 2.50 reichsmarks.*—Subject matter falls into three main groups. First is general, comprising fundamental concepts and units in mechanics, light and electricity, physical constants, conversion tables. Section on matter and materials includes tables on properties of numerous solids, liquids and gases, some of them not conveniently available elsewhere. Third and largest portion is devoted specifically to motor vehicles. Glossary of several hundred terms gives German, English, French and Italian equivalents.

VDI 72. HAUPTVERSAMMLUNG. *(Seventy-second Convention of the Society of German Engineers.) 92 pages, 166 illustrations. Published by VDI-Verlag G.m.b.H. Dorotheenstr. 40, Berlin, NW7, Price 3 Reichsmark.*—Several papers deal with the engineer's realtion to society. Others relate to divers subjects ranging from welding to viniculture and comparison of Roman ruins in Germany and North Africa. Among them are modern wood construction, flow of gas and liquid mixtures, and studies in combustion.

BERECHNUNG UND UNTERSUCHUNG VON KOLBENKOMPRESSOREN. *(Computation and Investigation of Piston Compressors.) By Dr. Tech. Franz Fröhlich. 21 large pages, 2 entropy charts, 38 diagrams. Published by VDI Verlag, Berlin. Price 7 Reichsmark.*—New entropy tables for air and for a mixture of 75% H_2 and 25% N_2, or synthetic NH_3 gas, have been computed for pressures up to 1,200 atmospheres. Tables previously available were found to be seriously inaccurate at pressures around 300 atmospheres and did not reach upper values now included. First portion of the monograph reviews thermodynamic theory involved; second half shows how entropy diagrams, supplemented by test data from existing machines, are used in computing performance of actual or projected compressors.

LIST OF FEDERAL GOVERNMENT PURCHASING OFFICES (1935). *Copies free from Machinery Division, Bureau of Foreign & Domestic Commerce, Washington, D. C.*—Unofficial list of field and main purchasing offices of the federal government.

WHAT'S NEW IN PLANT EQUIPMENT

HEADER PROTECTION

SINGLE belt of supported wall for protecting lower portions of headers and ends of tubes on straight-tube types of water-tube boilers. Panel supporting castings are bolted to drip pan which acts as horizontal frame member. Drip pan can be connected to boiler column. Protection independent of balance of wall. See Fig. 1, page 462, for sketch.

Geo. P. Reintjes Co., 2517 Jefferson St., Kansas City, Mo.

WELDING TORCH

CONSTRUCTED of extruded brass, Monel metal, and drawn copper with silver soldered tubes, Purox welding torch No. 35 has ribbed design on handle to reinforce and give easier grip. Ferrule type connections extend parallel to handle axis. Hexagonal socket arrangement permits welding head to be assembled in six positions. Hard-drawn copper tips.

Linde Air Products Co., 30 E. 42d St., New York, N. Y.

LUBRICANT BARREL PUMP

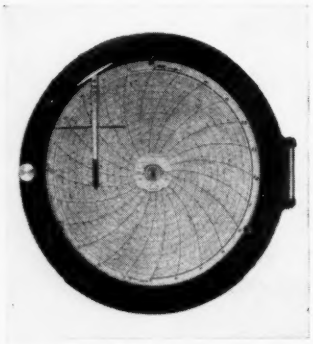
HIGH-PRESSURE, air-operated barrel pump for converting 100-lb. lubricant containers into power guns for industrial and truck lubrication. Utilizes Nitralloy piston. Low-pressure pump carries continuous flow of lubricant from container to high-pressure pump. Thence lubricant is delivered at rate of 18 oz. of regular lubricant per min., or 6½ oz. of extremely fibrous and heavy lubricants. Pressure is 33 times atmospheric to care for several outlets at one time. Provided with either 3- or 4-wheel trucks for portability, or base for stationary installation.

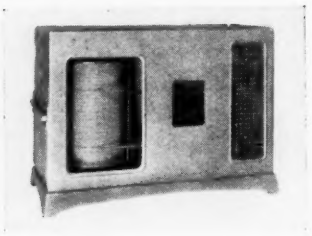
Stewart-Warner Corp., Alemite Division, 1826 Diversey Parkway, Chicago, Ill.

RECORDING METER

MJL No. 37 recording meter actuated by differential pressure produced by orifice, venturi tube or pilot tube inserted in pipe line, acting on flexible metallic bellows in instrument housing, and balanced by calibrated coil spring which compresses in direct relation to differential pressure. Movement is transmitted through pressure tight bearing and linkage to pen arm. Using suitable square-root chart, will record rate of flow directly. Bulletin B-101.

Morey & Jones, Ltd., 922 So. Hemlock St., Los Angeles, Calif.





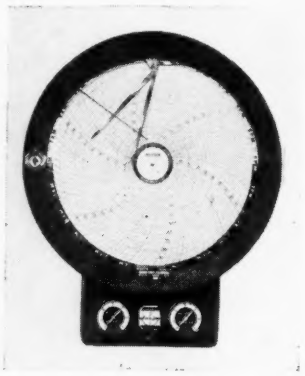
HYTHERGRAPH

SIMILAR to Weather Bureau Hydro-Thermograph, instrument gives simultaneous record of relative humidity by means of multiple human hair element and of dry-bulb temperature with special bi-metallic element, on common time lines.

Julian P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md.

AIR-OPERATED CONTROLLERS

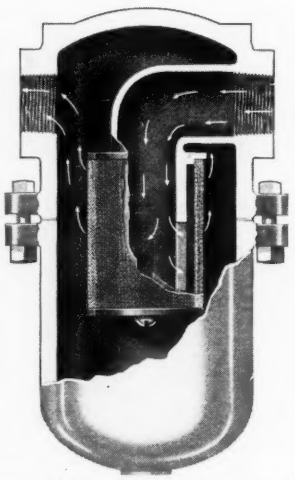
SERIES of recording and indicating, air-operated, controllers for temperature, flow, pressure and liquid level. Includes "Air-o-Line," with 1% to 150% throttling range, and automatic reset. Recognizes and corrects for magnitude, rate and direction of departure from control point. Throttling range and automatic reset valves adjustable with screwdriver without removing chart plate. Thermometer-type controllers for temperatures between —40 deg. F. and 1200 deg. F., and potentiometer-type controllers for temperatures between —300 deg. F., and 3400 deg. F. Also inductance bridge type and mechanical type flow controllers and liquid-level controllers combined to give remote operating characteristics of electric flow-meter and flexibility of air-operated control. Controllers for 30 in. of vacuum to 3,000 lb. per sq.in. pressure. Catalog No. 8900.



Brown Instrument Co., Wayne & Roberts Ave., Philadelphia, Pa.

SCREEN SEPARATOR

WATER and oil removed from steam or air by Type "S" separator which utilizes Gast patented principle of zig-zagging moisture and oil-laden vapor through several layers of coarse-mesh screen. Designed for pressures up to 150 lb. May be installed permanently in the line, as interior parts may be removed without disturbing connections. Sizes from ⅜ to 2 in.

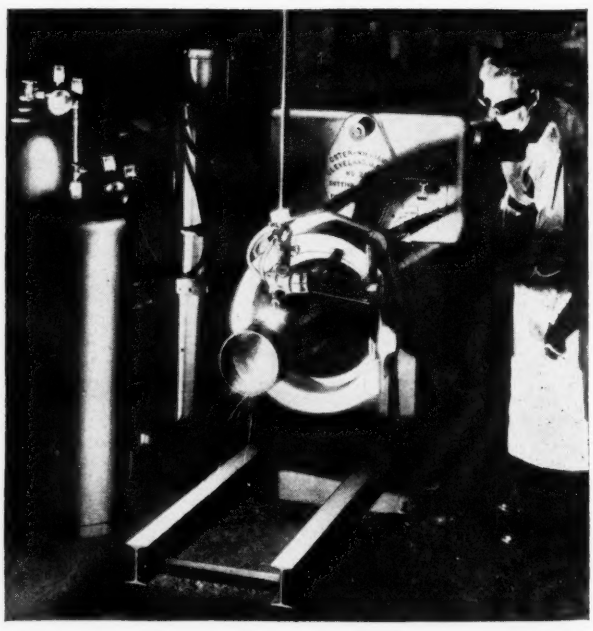


Johnson Corp., Three Rivers, Mich.

PIPE-CUTTING MACHINE

MACHINE No. 212 cuts pipe from 2½ to 12 in. in preparation for welding. Aluminum generating case mounted on rotating column can be swung in any direction. Pipe is placed on ball-bearing rollers mounted in adjustable supports which rest on double rails on welded steel base. Five possible settings.

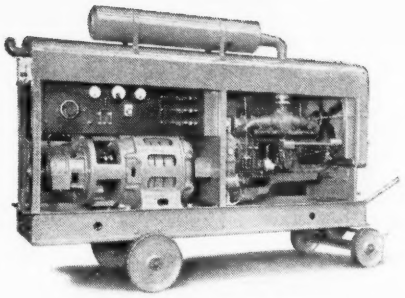
Oster-Williams, 2057 East 61st Place, Cleveland, Ohio.



PORTABLE POWER UNIT

GAS-POWERED with mounted exciter, these portable units have a rated capacity of 35 kw. for 240-volt, 3-phase, 60-cycle current. Switchboard includes voltmeter, ammeter, frequency meter, field rheostats, field discharge switch, meter switch and main line fused switch. Vacuum-type engine muffler can be detached for remote mounting.

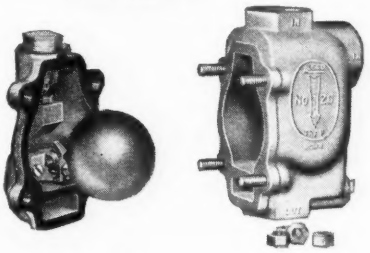
Harnischfeger Corp., Milwaukee, Wis.



AUTOMATIC ADJUSTABLE ORIFICE

ORIFICE automatically shifts position in accordance with major changes and rate of flow. Gate is sharp-edged orifice section which changes in position varying size of orifice opening through which fluid measured must pass. Movable stops limit stroke of hydraulic piston so that orifice segment rests on either one or two separate positions. Piston governed by solenoid-actuated valve in turn commanded by contacts made in recording meter. Through solenoid valve hydraulic pressure is admitted to either end of cylinder, while other end opens to drain.

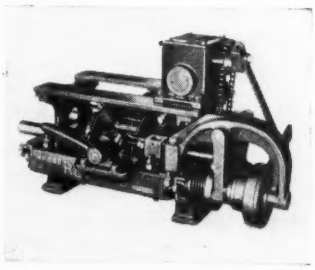
Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.



STEAM TRAP

COMBINATION float and thermostatic steam trap, has working mechanism on cover with piping connections on body. Reversible stainless alloy steel valve and seat. Limit stop on float lever prevents elevation of float beyond normal. Six capacities.

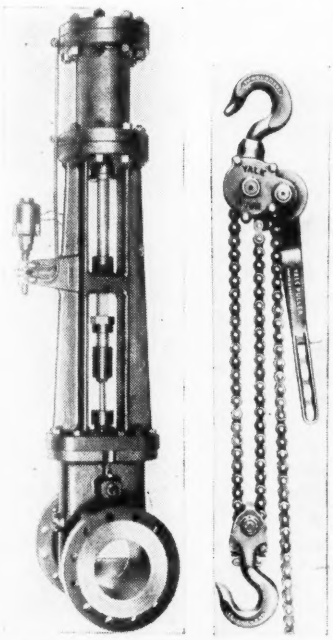
American District Steam Co., North Tonawanda, N. Y.



VARIABLE-SPEED RATCHET CONTROL

POWER input shaft of variable-speed transmission driven from any source of power, drives to proper ratio gear reducer through roller chain. Output shaft of reducer connected by adjustable arm to ratchet on extension of speed-changing screw. Adjustable arm varies timing of control. Shifted back by hand to starting position when end of run is reached, and ratchet reset by lever.

Reeves Pulley Co., Columbus, Ind.



PULL-LIFT TOOL

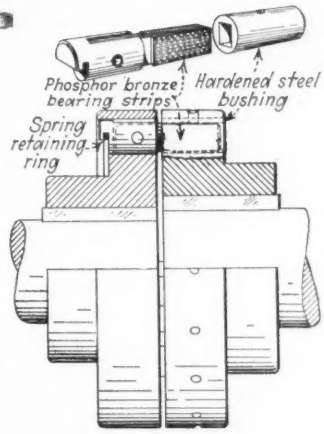
LIGHT-WEIGHT tool made of heat-treated chrome-nickel steel gears, sprockets and load brake parts may be used in either horizontal or vertical position to stretch cables, pull in boiler tubes, pull machines into position, etc. Used vertically, will lift up to 6 tons. Made in ¾-, 1½-, 3- and 6-ton capacity. Called "Pul-Lift."

Yale & Towne Mfg. Co., Philadelphia, Pa.

COUPLINGS

RATINGS to 4,200 hp. for 100 r.p.m., and for shafts up to 13¾-in. diameter are included in 21 regular sizes of "Flexpin" couplings consisting of bundle of steel laminations copper coated to resist rust, held in slotted keeper by hardened steel cross pins, welded type. Hardened steel bushings with rectangular broached holes to receive long, sliding ends of flexpins are locked in place in other flange. Bulletin No. 49.

Smith & Serrell, 1 Halsey St., Newark, N. J.



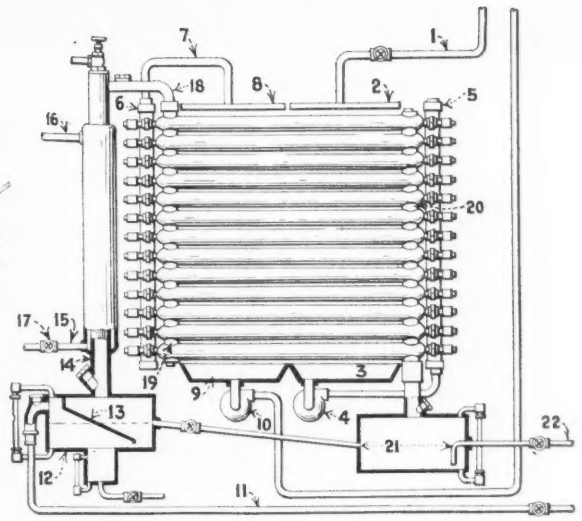
PAINT PROTECTOR

"TRIPLE LIFE" paint protector provides highly resistant coating on surfaces such as paint (exterior and interior) varnish, lacquer, metal, etc., which tend to oxidize. Applied by spray gun, soft cloth or lamb's wool.

Franklin Research Co., 5134 Lancaster Ave., Philadelphia, Pa.

AUTOMATIC DOUBLE-PIPE COUNTER-CURRENT AMMONIA CONDENSER

IN THIS condenser, special means are taken to facilitate cleaning water circulating and cooling tubes. Individual tubes may be shut off from system and cleaned without interference with continuous operation. Water supply in circulating system flows over discharge ends of condenser tubes, then through inside tubes, counter-flow to vapor, finally over intake ends of condenser tubes to insure maximum heat transfer, provide means for converting superheated gas into saturated vapor, and wash out oil and oil vapors before condensing tubes are reached.



Water from cooling tower or other supply is delivered through pipe 1 into sprinkler head 2, directly above condenser tubes at discharge ends. Water flows downward over exterior surfaces directed by baffle plates to tank 3. Pump 4 delivers water to headers 5, then into tubes in counter flow direction to ammonia vapors. Water passes to header 6 through pipe 7 to sprinkler head 8 at inlet ends of condenser tubes and is collected in tank 9, from which pump 10 removes it to cooling tower. Superheated ammonia gas discharged from compressor delivered by pipe 11 into drum 12, which is at all times maintained half full of liquid ammonia. Baffle plate 13 directs hot gases through liquid ammonia, converting them into saturated vapor, which enters water-jacketed condensing column 14 for partial condensation. This maintains constant level in drum 12. Water is circulated through water jacket and around column 14 to inlet pipe 15 and overflow pipe 16 with valve 17, so cooling water and amount of liquid in drum 12 may be regulated. Saturated vapor is discharged from top of column 14 into pipe 18, which is connected with upper end of inlet header 19 where vapors flow into all condenser tubes, passing from inlet to outlet, where they are completely condensed, liquid ammonia draining into outlet header 20 and drum 21, from which it is returned to the expansion coil by pipe 22. Unit is all welded with shielded ammonia joint tested to 375 lb. hydrostatic pressure.

J. Henry Beckman Co., 932 57th St., Oakland, Calif.

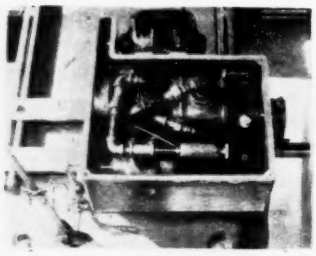
WATER GUN FOR CONDENSER CLEANING

"CONCO" water gun with 1-in. pipe-size inlet has large capacity to prevent pressure drop in shooting cleaners swiftly through larger ($\frac{7}{8}$ and 1-in.) sizes of condenser tubes with low-water pressures. Adaptable to any size tube by changing nozzle. Renewable valves, valve seats and other parts. Net weight, 4½ lb.

Condenser Cleaners Mfg. Co., 422 First Ave., Pittsburgh, Pa.

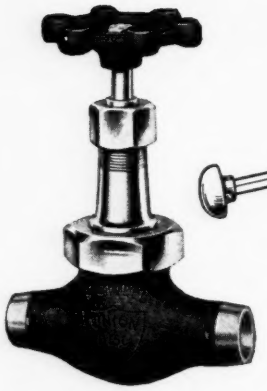
HYDRAULIC SPEED CONTROL

HYDRAULIC automatic (Hydraumatic) control for use with Reeves variable-speed transmission. Lever attached to element which indicates required speed, transmits motion to shifting levers which vary diameter of disk and V-belt. Operating parts in dust-proof, cast-iron enclosure on special mountings above transmission. A.c or d.c. motor operates geared pump through sprocket and roller chain under splash guard. Facing shaft end, motor must run counter-clockwise. Oil is taken up through suction pipe by geared pump and forced under pressure through pipe to tee. If extended lever is in neutral position, oil will flow through relief valve to tank and no rotation is transmitted to shifting screw. When lever is moved



left or right, differential mechanism operates to move valve rod in or out, providing pressure in 2-way valve which causes oil to flow to fluid motor connected to shifting screw of transmission by sprocket and chain. Will actuate transmission to increase or decrease speed depending on which way extended lever is moved.

Reeves Pulley Co., Columbus, Ind.



VALVES FOR COPPER TUBING

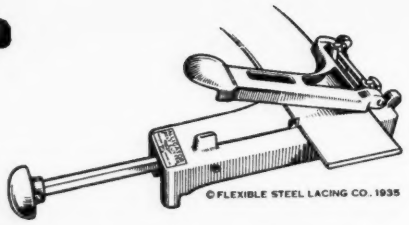
BRONZE valves are connected to Mueller Brass Co.'s streamline copper pipe by feeding wire solder through feed hole in valve after pipe has been assembled, and heating with blow torch. Liquefied solder is carried around entire surface between pipe and valve by capillary action. Visible as bright line at outer edge between pipe and valve. No previous tinning necessary. Available in ¼ to 3-in. sizes, blow, rising and non-rising stem gate valve, and check valve. Bulletin.

William Powell Co., 2525 Spring Grove Ave., Cincinnati, Ohio.

CONDENSATE RETURN UNIT

54 sizes and types of automatic "Monobloc" condensate return units with ratings ranging from 2,000 to 40,000 sq.ft. of direct C.I. radiation or equivalent. Condensate flows by gravity into storage tanks, trips float switch at predetermined depth, and automatically starts motor. When at predetermined minimum level motor is automatically stopped. Pump capacities range from 3 to 60 g.p.m.; storage tank capacity from 22 to 98 gal., and discharge pressures vary from 10 to 40 lb. per sq.in. Bulletin W-321-B6.

Worthington Pump & Machinery Corp., Harrison, N. J.



BELT CUTTER

PATENTED 8-in. flat belt cutter has knife mounted on plunger in slot, operated by direct arm push. Cut is made by pushing alloy-steel, replaceable, knife through belt from one edge to other. Belt held by clamp which is also guard for blade. Weighs 4 lb. 3 ozs.

Flexible Steel Lacing Co., 4607 Lexington St., Chicago, Ill.

OIL-RESISTANT BELT

MATERIALS used are said to make belt 100% oil resistant. Made in both V-type and flat cable cord type.

L. H. Gilmer Co., Tacony, Philadelphia, Pa.

CONDENSER TUBE CLEANER

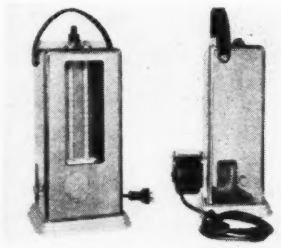
"CONCO" cleaner, in four sizes from $\frac{5}{8}$ to 1 in., has tempered stainless steel blades ground to sharp edge for maximum effectiveness. All other parts brass to prevent rust.

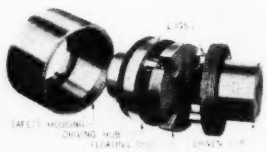
Condenser Cleaners Mfg. Co., 422 First Ave., Pittsburgh, Pa.

THERMO-SHIELD PSYCHROMETER

AIR sample drawn through top to eliminate error due to heat radiations from surrounding objects in motor-operated thermo-shield psychrometer. Mechanism in case with glass window for thermometer visibility and integral rack for psychrometric tables. Thermometers 10 in. long, graduated from —5 to +130 in ½ deg. increments. Fan operated by 110 volt a-c motor. Case 7 in. square by 13 in. high.

Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md.





FLEXIBLE COUPLING

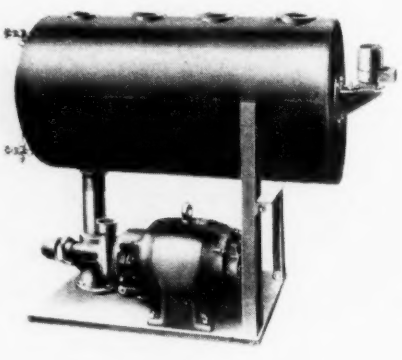
SELF-ALIGNING flexible coupling compensates for parallel and angular misalignment. Two round lugs set into each of two driving hubs. Lugs fit in recesses in periphery of bone fiber drive disk. Disk tends to float due to centrifugal action. Housing encloses coupling and acts as guard.

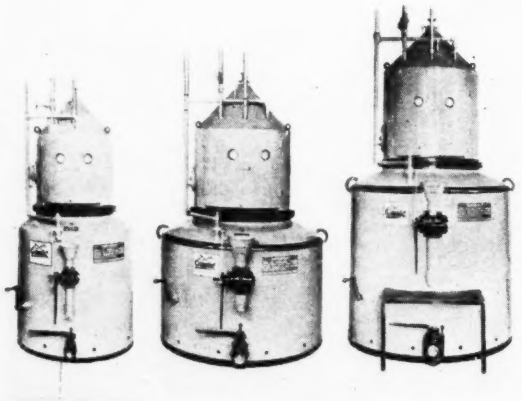
Alloy Products Corp., 221 Madison St., Waukesha, Wis.

MEDIUM PRESSURE ACETYLENE GENERATORS

THREE sizes of Oxweld type MP-5 acetylene generators for stationary service have capacities from 300 to 1,000 cu.ft. per hr. Controls protected by padlocked housing. Self-contained gravity-type feed control bolted to inside of upper section. Diaphragm-type feed control causes valve to open, releasing carbide evenly to maintain constant pressure.

Linde Air Products Co., 30 E. 42d St., New York, N. Y.





ELECTRIC HAMMER AND DRILL

"Do-All" is primarily an electric hammer which, with simple adjustment, may be used as electric drill, light grinder and buffer. Hammer mechanism has only two working parts, both specially treated steels. Universal motor with forced-draft ventilation, operable from any light socket. Hammer member may be removed and tool used as electric drill with capacity of $\frac{3}{8}$ in. by opening chuck and loosening cap screw. It may also be used as portable grinder and buffer. When used as hammer with star drills, tool drills holes in concrete and masonry up to $1\frac{3}{8}$-in. diameter, and with special tools does chipping, chiseling, cutting and vibrating.

Wodack Electrical Tool Corp., 4627 W. Huron St., Chicago, Ill.

TOTAL TIME METER

Meter totalizes running or idle time on any individual a.c. powered unit. Registering mechanism has four dials, will register 9,999 hours before repeating. Meter may be mounted at distance, connected by single pair of wires. Meter including self-starting, 60-cycle synchronous motor is contained in 2-piece Moldarta case, $3\frac{1}{2}$ in. diameter, over-all length about $3\frac{1}{4}$ in. Also furnished with special register providing one revolution per hour of sweep hand.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CIRCULAR SLIDE RULE

Vest pocket, circular "Mascot" slide rule, $2\frac{3}{4}$-in. in diameter, given squares, square roots, logarithms and reciprocals of all numbers. Trig scales gives sines and tangents. Unbreakable. Black graduations on white celluloid.

Tavella Sales Co., 25 W. Broadway, New York, N. Y.

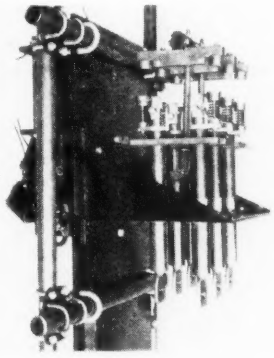
SEALING COMPOUND

"TiteSeal" supplied in three densities, light weight for sealing finely machined joints, rust and corrosion prevention on threads, battery terminals, etc.; medium weight for general gasket use, water pump packing filler; heavy weight for heavy gasketing, general calking, etc. In tube or can.

Fostoria Pressed Steel Corp., Fostoria, Ohio.

OIL BLAST CIRCUIT BREAKER

Adaptable for limited space. Type FK-42 is rated at 600 amp., 7,500 volts; 800 amp., 2,500



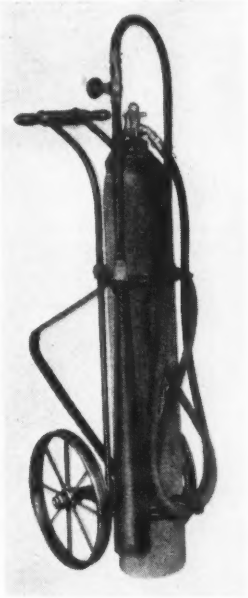
volts, and 25,000 kva., interrupting rating. All designs double and triple-pole, single throw, with all poles in single rectangular welded plate steel tank. May be mounted directly back of panels or in switch houses or metal-inclosed switchgear. Manually or electrically operated. Have compact construction, silver-to-silver main contacts protected by arcing contacts, oil blast baffles for high-speed interruption, single tank for all poles, no external moving parts. Complete line of accessories available.

General Electric Co., Schenectady, N. Y.

TEST-LITE AND FUSE PULLER

This combination test-lite and fuse puller with 18-in. flexible leads will test circuits of 110 to 550 volts, and will test, remove or replace fuses from 30 to 100-amp. capacity. Also can be used for handling "live" electrical parts, adjusting cut-out clips and "fishing" for loose articles surrounded by live wires. Molded reinforced Bakelite 7 in. long and weighs 6 oz. Test pins mounted in handle ends and adjusted for various spans by opening and closing handles. Test light inclosed in one handle to safeguard from damage. Either one or two leads with each tool, as required. Each has $1\frac{5}{8}$-in. lead points of small diameter and with chisel points, for insertion or wedging into knife-type switches and cut-outs.

Ideal Commutator Dresser Co., Sycamore, Ill.



FIRE-FIGHTING EQUIPMENT

Designed especially to combat fires in highly inflammable liquids and for grease and electrical fires, "C-O-TWO" equipment is non-freezing and equally effective inside or outside. Available in portable, hose and truck type, latter being illustrated. Units are sealed against leakage and provided with shutoff valve for maneuvering around fire. Valves made from naval brass forgings chromium finished. Horn is non-conductive. Approved by underwriters Laboratories.

C-O-TWO Fire Equipment Co., Pyrene Building, Newark, N. J.

PORTABLE POTENTIOMETER

Portable potentiometer designed to enable pyrometer users to check their potentiometers, millivoltmeters and thermo-couples quickly and accurately. Combination of step-switch and slide wire makes it possible to read indicating scale to 0.1 millivolts over total range of 71 millivolts. Indicating scale 17 in. long, making smallest scale division over 1/16 in. wide. Fully enclosed, suspension type galvanometer has a very short period so readings can be taken rapidly. Two sets of binding posts and a toggle switch provided for thermo-couple checking.

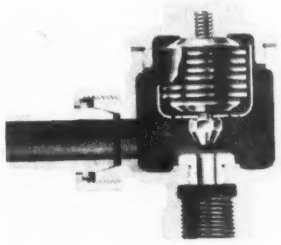
In addition can be used as measured source of E.M.F. in checking recording poteniometers of self-balancing type. Circuit draws only three milliamperes from dry cell, giving dry cell life of several months and permitting instrument to be used for several hours on one standardization of battery current.

Instrument is $9\frac{3}{8}$ in. wide by $10\frac{1}{4}$ in. deep by $6\frac{3}{4}$ in. high, and weighs only $12\frac{3}{4}$ lb.

Brown Instrument Co., Philadelphia, Pa.

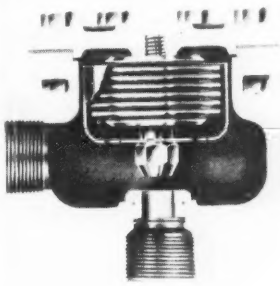
STEAM TRAP

Style "AU" Trap has union connection and is of bronze, for use on radiators and unit



heaters where reduced high-pressure steam is used. Pressure up to 150 lb. will not damage bellows element. Bellows of phosphor bronze tubing hydraulically formed, with end plates brazed on to withstand high pressures and temperatures. Style "C" is of cast iron construction for pressures up to 200 lb., and made in angle type so trap drains itself when steam is turned off (desirable for outside installations; prevents freezing). Trap also has brazed bellows element which gives it intermittent discharge and large capacity for both water and air. Valves and seats hardened stainless steel. Bulletin 535.

W. H. Nicholson & Co., 213 Oregon St., Wilkes-Barre, Pa.



POSTMAN'S HOLIDAY

Delegates to the convention of the National Association of Power Engineers take a postman's holiday in the engine room of the Ford Exposition Building, Balboa Park, San Diego. L. King, chief engineer, Ford Building, explains the compressor installation. Left to right: L. King; Ray Baker, president of California No. 2, largest district in the United States; Thomas R. Horlihy, vice-president of the Board of Mechanical Engineers in Los Angeles, and past national president of the N.A.P.E.; Bob Walters, past president of California No. 2; Claude Barrett, Ted Shoebridge, Odina Samson, and R. N. Samson, secretary of California No. 9, San Diego

POWER LINES

Safety Code for Pressure Piping

American Standards Association has approved the American Standard Code for Pressure Piping, providing for a general safety code for pressure piping which correlates regulations for the design, insulation and tests of piping systems with suitable dimensional standards and material specifications. Primarily a safety code describing minimum requirements to which piping systems, which carry sufficient pressure to make substandard piping installations dangerous, must conform in order to eliminate potential hazards, this code does not consider systems operating at less than 15 lb. gage. All valves, fittings and pipings for boilers as prescribed in the A.S.M.E. Power Boiler Code are considered as part of the boiler installation and hence are outside the scope of this code. Connecting piping to economizers, heater tanks and other pressure vessels are under the requirements of the code. More than 40 organizations and societies cooperated in writing the code. The 164-page book may be secured at $1 per copy from the American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.

$20,000,000 Project

BUREAU OF RECLAMATION, Denver, Colo., proposes to proceed with new Central Valley Water Project, Calif., in the fall. The development will provide water supply for a large area around Friant, Kennett and Antioch, and will include: Steam-electric power plant at Antioch, $4,500,000; electric-operated pumping system, $1,931,000; dam construction at Friant, $1,000,000; Madera irrigation canal and system, $500,000; Contra Costa conduit system, $500,000; Friant-Kern irrigation canal and system, $6,146,000; dam at Kennett, $5,162,400. A Federal appropriation of $20,000,000 has been made.

Boston's Smoke Problem

Smoke prevention in South Boston featured recent hearings before a legislative committee considering bills requiring Boston Edison Co. and Boston Elevated Railway to cover their outdoor storage piles and to eliminate dissemination of dust and cinders from the stacks of their generating plants in that section of the city. It was shown that both utilities maintain excellent combustion conditions at their stations, and other sources of smoke diffusion were cited as in large measure responsible for the troubles.

David A. Chapman, a Boston engineer formerly heading Massachusetts Smoke Inspection, declared that South Boston is the victim of exposure to smoke conditions originating throughout the metropolitan area, and that the present smoke inspection law in Massachusetts does not give the director of the division power over dust or fly ash. The area covered by the law is now about 350 sq.mi., and the population is about 2,000,000. Mr. Chapman pointed out that the Boston Edison station at L Street, South Boston, is not sufficiently loaded to give much trouble from smoke. He stated that at least 3,500 lb. of soot are daily carried into the South Boston area from the round houses of the New Haven Railroad at Southampton St., and that this could be controlled by the installation of suitable soot-washing devices. No engineer has as yet been able to stop the blowing of dust from coal piles as the fuel is removed from cargoes. A quiescent coal pile can be covered with various inexpensive chemical solutions to keep down dust blowing, however. A canvas fence even 60 ft. high would not do a great deal of good except in regard to surface winds, the speaker said. At least 0.5% of the stored coal in piles is lost, which amounts to substantial yearly costs in storages as large as these of the Elevated and Edison companies. Cinders cannot be caught with a precipitator unless the plant is provided with a cinder collector. Mr. Chapman advocated appropriation by the Legislature to permit the smoke inspection division of the D.P.U. to be increased by about 6 men, pointing out that if this is done conditions can be much bettered in the Boston area.

Plant Operators Defended

H. Ware Barnum, general counsel Boston Elevated Railway, reviewed the efforts of the company to reduce smoke conditions. He said that cinder catchers had been provided at the station 8 years ago and had since been renewed. The prevailing westerly winds carry smoke seaward from the O Street stacks. The adjacent railroad yards are the main offenders. To inclose the elevated railway company's coal storage fields as specified would cost about $2,000,000. If the amount of coal stored was cut down to a 3-months' supply, the cost of inclosing the yards would be about $600,000.

Mr. Barnum said that the Elevated company had given instructions to have the coal wet down and that it is investigating the practicability of having the coal impregnated with oil at the mines to reduce dust. This will have to be studied from the point of view of spontaneous combustion.

After the above hearings, the House voted by 75 to 55 against requiring the coverage of coal fields, but the bill to compel the two utilities to remove the smoke nuisance was passed in the lower chamber by a roll-call vote of 110 to 95. Much praise was accorded Boston Edison and Harvard Medical School for equipping Kneeland St. heating plant of the former and Longwood Ave. plant of the latter with smoke-preventing devices.

SOCIETIES

A.I.E.E. will sponsor a joint engineers' meeting and inspection trip at Wilkes-Barre, Pa., Sept. 28, in cooperation with the A.S.M.E., A.I.M.E., and Wilkes-Barre Chamber of Commerce. Inspection trips will be made through mines of Wilkes-Barre, Pa., and several manufacturing plants under the direction of W. H. Lesser, chairman of arrangements committee.

ENGINEERING FOUNDATION has appointed

a Welding Research Committee to conduct a review of world welding literature, aid worthy projects functioning under the Fundamental Research Comm. of the Amer. Bureau of Welding, and sponsor research investigations. Project will be started by funds contributed by Engineering Foundation and funds and services supplies by industry. The project is sponsored by A.I.E.E. and Amer. Welding Soc.

AMERICAN WELDING SOCIETY will hold its Fifteenth Fall Meeting Sept. 30 to Oct. 4 at Palmer House, Chicago, Ill. Afternoon technical session Oct. 2 will give methods of minimizing distortion in pressure vessels by J. T. Phillips, Foster Wheeler Co. and in repair welding by George Hettrick, president, Anchor Welding Service, Inc.

FOURTH INTERNATIONAL HEATING & VENTILATING EXPOSITION will be held in the new International Amphitheatre, Chicago, Jan. 27-31, 1936. 230 spaces have been taken by 132 exhibitors. An illustrated synopsis of the development of heating and ventilating will be presented. Expert advice on installations most desirable for specific needs will be available. Also comprehensive displays of equipment under the groupings: Hydraulic, Steam Heating, Air, Refrigerating, Control, Central Heating, Insulating, and Auxiliaries.

PACIFIC COAST CONVENTION of the A.I.E.E. held in Seattle, Wash., Aug. 27-30, included sessions on power transmission and distribution, electrical machinery, communication, student technical sessions, electrophysics, instruments and measurements, and other selected subjects.

THE 90TH MEETING of the American Chemical Society was held in San Francisco, Aug. 19-23. Among papers presented were: "Removal of Silica from Solution at Boiler Temperature", and "Continuous Production of Carbon Dioxide and Ammonia Free Distilled Waters", by Frederick G. Straub; "Natural Gas in California, 1934", by Claude C. Brown; "The Practical Solution to the Smoke Nuisance in Salt Lake Valley", by S. Clark Jacobsen and George W. Carter; "Low-Temperature Carbonization of Coal of the Pikes Peak Region", by Frank W. Douglas; "Low-Temperature Thermal Treatment of Coal by the Records-Louttit Process", by James G. Louttit; "Ignition Temperature of Coke and Air Required to Support Combustion", by C. R. Holmes and J. D. Davis; "The Reactivity of Coke" (an improved method for determining the reactivity of coke in carbon-dioxide) by D. A. Reynolds and J. D. Davis, and "The Structure of Lubricating Greases," by Bruce B. Farrington.

TUBULAR EXCHANGER SECTION, Heat Exchange Institute, recently held a meeting at Buckwood Inn, Shawnee-on-Delaware, to discuss problems caused by abandonment of NRA and standards relating to heat exchangers.

AMERICAN OIL BURNER ASSOCIATION has changed its name to Oil Burner Institute and has adopted a broader-gage program. Headquarters continue at 342 Madison Ave., New York, N. Y.

UNIVERSITY OF ILLINOIS's Short Course in Coal Utilization June 11 to 13 included talks on coal analyses, combustion equipment, boiler test calculations, coal cleaning, preparation and merchandising, fuel engineering, stokers, heating valves, control equipment, ash fusibility and economic problems.

OBITUARIES

DR. ARTHUR DEHON LITTLE, 72, president of Arthur D. Little, Inc., Cambridge, Mass., and a member of the corporation of the Massachusetts Institute of Technology, died Aug. 1. Dr. Little's practice included many important contributions to progress in the petroleum field and much work in fuel and lubrication oil studies for power service. He was honored by many engineering societies and universities here and abroad. Dr. Little's will transferred the controlling interest in his consulting-engineering house to M.I.T., which will share in the income and ultimately acquire the property.

FRANCIS M. ANDREWS, 89, formerly with Worthington Steam Pump Co., New York, Manchester (Mass.) water department died July 23.

HENRY Z. COBB, 68, development engineer for United States Rubber Co., Providence, R. I., died July 20.

JOHN C. LIGGETT, 65, died Aug. 11. He constructed the generating plant of the Chicago World's Fair in 1893.

E. HAROLD NEWHALL, 60, president of Gustavo Co., Boston, Mass., died Aug. 9.

CHESTER H. NORWOOD, 46, former chief engineer of the A. B. See Electric Elevator Co., died July 27.

COMING MEETINGS

American Welding Society—Fall meeting in conjunction with National Metals Exposition, Chicago, Ill., Sept. 30. W. Spraragen, secretary, 29 West 39th St., New York N. Y.

Ass'n of Iron & Steel Electrical Engineers — Annual convention and exposition, Wm. Penn Hotel, Pittsburgh, Pa., Sept. 24-26. Headquarters, 1010 Empire Bldg., Pittsburgh.

15th Exposition of Chemical Industries —Grand Central Palace, New York, N. Y., Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York, N. Y.

WILLIAM POTHIER, 54, operating steam engineer at Slade St. Laundry, Providence, R. I., fell to his death Aug. 8, from a staging erected for a stack repair job.

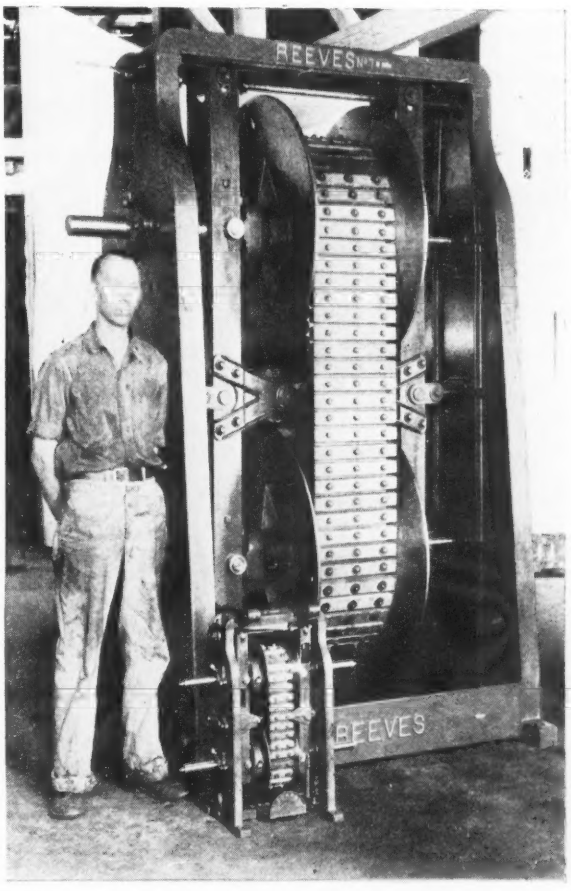
OLIVER STEVENS, 95, power plant engineer for the Boston "Globe", died Aug. 6.

PERSONALS

IRVING E. MOULTROP, chief engineer of the Boston Edison Co., since 1926, retired Aug. 1. Mr. Moultrop began work with the Whittier Machine Co., Roxbury, Mass., in 1883, and then entered th Boston Edison ranks in 1892 as chief draftsman. He was mechanical engineer from 1897 to 1913; assistant superintendent of construction bureau, 1913 to 1926; and six years later became chief engineer and assumed the duties of superintendent of the construction bureau. Mr. Moultrop was in direct charge of development and construction of the Edgar

LARGEST VERTICAL TRANSMISSION

The largest vertical design variable-speed transmission ever constructed has recently been built by Reeves Pulley Co. This unit gives 6:1 speed ratio, is one of nine transmissions of varying sizes which will control the speeds of a paper saturating, coating, drying and cutting machine used in making roofing and shingles.
The unit is 8 ft., 2½ in. high, nearly 5 ft. wide and 50 in. deep. Note comparison with a man of average size and with a No. 00 — second to smallest size — Reeves transmission in foreground. Diameters of the disks are 39 in. and a V-belt 12 in. wide and more than 14 ft. long is required for this 5,170-lb. giant.



Station at North Weymouth. He is a past vice-president of the A.S.M.E. and vice-president of the A.I.E.E., and American Engineering Council, besides being president of the Engineers Club of Boston.

J. A. COLLIER has been appointed Chicago representative of Laclede Stoker Co., with office at 417 South Dearborn St.

FRANK P. COX, manager of the West Lynn works of the General Electric Co., since 1913, retired Sept. 1.

THOMAS ALLSOP, retired chief engineer of Waterside Stations, will be succeeded by Foster L. Moore.

C. E. BLEE, assistant engineer of British Columbia Electric Railway Co., Vancouver, B. C., has been appointed hydraulic engineer with TVA.

WILLIAM GOODMAN, former consulting engineer of Chicago, has joined the engineering staff of the Trane Co., La Crosse, Wis.

R. E. W. HARRISON, chief, machinery division, U. S. Dept. of Commerce, is now associated with Eugene C. Cross at 1818 Packard Bldg., Philadelphia, Pa., as a consulting engineer.

WALLACE L. HIGGINS has become manager of the New York district, with offices at 1440 Broadway, New York, N. Y., for McClave-Brooks Co., Scranton, Pa. Winfield Roeder, formerly in charge of New York territory, has been transferred back to Philadelphia.

J. E. HOLVECK has been appointed special sales engineer for Worthington Pump & Machinery Corp., Harrison, N. J., operating from its Pittsburgh office and including Cleveland, Detroit, Chicago and Buffalo.

SIR HAROLD HARTLEY, chairman of the British National Committee, was elected chairman of the International Executive Council of the World Power Conference at a meeting of the council in Holland July 17.

WILLIAM E. LUNDGREN, inventor of the Lundgren box motion, and plant engineer at the Slater Mill, Webster, Mass., has made the first radical change in the principle of bobbin-changing in more than 40 years. Its purpose is to solve the mis-threading and tension problems responsible for loose picks, shiners, third-ends, and shutdowns. The new method will increase the use of the bobbin-changing principle in silk and rayon weaving.

ROY C. KENDALL, formerly Wisconsin representative for Medart Co., St. Louis, Mo., has been elected general sales manager.

J. C. MAHONEY, formerly with C. H. Leach Co., is in the heat exchanger sales department of Henry Vogt Machine Co.

HAROLD G. MEISSNER, M. E., has been elected vice-president in charge of engineering and a director of Crew-Taylor Engineering Corp., 305 East 45th St., New York, N. Y. He has been chief engineer of this company since shortly after its organization in 1933.

J. D. ROSS, Seattle municipal power plant operator, has been appointed chief consulting engineer of PWA's recently organized power division. K. Sewell Wingfield has been transferred from the finance division to assistant director of the power division.

Harry S. Brown

HARRY S. BROWN has been elected president of Foster-Wheeler Corp., New York. Mr. Brown has been with the company since 1919, when he resigned from Power Specialty Co. to accept the position of vice-president of Wheeler Condenser & Engineering Co. When the two companies combined in 1927 he became vice-president in charge of sales and a director. Mr. Brown, succeeds his brother, J. J. Brown, who continues as chairman of the board. David McCulloch, formerly secretary and general manager, was elected executive vice-president and Walter F. Keenan, Jr., George B. Ferrier and J. J. Nelis were elected vice-presidents. P. N. Wenz was elected secretary.

HARRY W. MCQUAID, Republic Steel Corp., will present the Edward De Mille Campbell Lecture at the seventeenth National Metal Congress & Exposition in Chicago, Oct. 2.

G. H. PALMES, former General Manager of The Raton Public Service Co., and City Water Works, Raton, N. Mex., is now manager of Fort Collins, Colorado Light and Power Department.

ARTHUR L. PAULS has been appointed construction engineer for Pickwick Landing Dam, Savannah, Tenn.

G. B. MATTINGLEY, formerly with Edge Moor Iron Co., is now in boiler sales department of Philadelphia office, Henry Vogt Machine Co.

O. W. MCMULLAN, formerly Chief Metallurgist at the Timken-Detroit Axle Co., Detroit, has been added to the research staff of the International Nickel Co., Inc., Bayonne, N. J.

CHARLES W. DANIELS has been appointed general sales manager for Harnischfeger Corp., Milwaukee, Wis. He is succeeded in Philadelphia by L. M. Stout.

DR. EVERETT P. PARTRIDGE has been appointed director of research, Hall Laboratories, Inc., Pittsburgh, Pa.

CLINTON H. QUIRK has transferred from Vento Division of American Radiator Co. to the eastern territory of Trane Co., La Crosse, Wis.

BENJAMIN F. RUSH, city agent in the Inspection Bureau, and oldest employee of the Brooklyn Edison Co. in point of service, has retired.

ROSS RATHBUN has been appointed general sales manager of the Westinghouse Electric Elevator Co.

FRANK W. SMITH, president of Consolidated Gas Co., was elected president of the Queens Co., succeeding Mr. Snyder, who withdrew because of the retirement plan. Floyd L. Carlisle, chairman of the Board of New York Edison & Consolidated Cos., filled Mr. Smith's position as chairman of the board of the Queens Co.

V. WEAVER SMITH, formerly assistant to the president and head of the Oil Heater Department, Lummus Co., New York, has become vice-president in charge of business activities of Broderick Mfg. Co., Muncie, Ind. The latter company is one of the oldest and largest manufacturers of oil-country boilers.

HENRY F. SPROULL, formerly of Griscom-Russell Co. metropolitan sales, and operating assistant to the vice-president in charge of operation of Public Service Production Co. of New Jersey, has recently joined Abrahamson Corp., Buffalo, N. Y., on engineering sales.

F. W. THOMAS, for the last ten years New York district manager of the coupling division, Bartlett Hayward Co., has joined John Waldron Corp., New Brunswick, N. J. as general manager of sales of the Francke coupling and silent gear departments. As of July 15, the sales staff of John Waldron Corp. will handle sales of its products directly in place of through Smith & Serrell, Newark, general sales agents heretofore.

A. M. TORPEN has been transferred from Pickwick Landing Dam to Knoxville, Tenn., office of TVA hydraulic engineering department.

GEORGE E. SEABURY, superintendent of Station Engineering Dept., Edison Electric Illuminating Co., Boston, retired Sept. 1.

A. J. O'LEARY has been appointed assistant to the general manager of sales, Luken Steel Co., Coatesville, Pa. He has been with the company for 19 years.

ARNOLD WEISSELBERG, consulting engineer, has moved from Jersey City to 1071 Sixth Ave., New York, N. Y.

W. A. TEMPLETON, inspector of electric and gas meters for the Dominion Government in British Columbia was recently honored by award of a Jubilee Medal. He entered the Federal service 39 years ago, and is believed to have the longest service of any civil servant at Vancouver, B. C.

H. S. VASSAR, laboratory engineer, Public Service Electric & Gas Co., Irvington, N. J., was elected president of the A.S.T.M. at the annual meeting June 25 in Detroit. A. E. White, professor of metallurgical engineering, University of Michigan, Ann Arbor, Mich., was elected vice-president. Executive committee members: W. H. Graves, metallurgist, Packard Motor Car Co.; R. L. Hallett, National Lead Co.; N. L. Mochel, Westinghouse metallurgical engineer; H. H. Morgan, manager of Rail and Track Fastenings Dept., Robert W. Hunt Co.; and W. R. Webster, chairman of the board, Bridgeport Brass Co.

ELLERY L. WILSON, general superintendent of Rumford Chemical Works, Rumford, R. I.,

has been elected president of the Providence Engineering Society for the year beginning July 1. H succeeds Ernest F. Walsh, test engineer of the power department, Narragansett Electric Co. Other officers elected were: vice-presidents, Alton C. Chick and Clarke Freeman, Manufacturers Mutual & Fire Insurance Co., secretary. William R. Benford of the Civil Engrg. Dept., Brown University; treasurer, Everett L. Freeman, plant engineer, Brown & Sharpe Mfg. Co.

BUSINESS NOTES

ASHMEAD-DANKS Co., Rockefeller Bldg., Cleveland, Ohio, has been appointed distributor in northern Ohio for Ashton Valve Co., Boston, Mass.

AVERY & SAUL Co., South Boston, Mass. have been appointed distributors for the Globe Steel Tubes Co., Milwaukee, Wis.

BABCOCK & WILCOX Co. has moved all divisions from 130 Cedar St. to 19 Rector St., New York. General office of the company will continue at 85 Liberty St.

A. M. BYERS Co., Pittsburgh, Pa., has added steel pipe to its list of products.

CARRIER ENGINEERING CORP., Newark, N. J., has signed a contract with Equipment Acceptance Corp., subsidiary of Commercial Investment Trust, for long-time financing of air-conditioning and commercial refrigeration installations under the F.H.A. National Housing Act.

CENTERVILLE ELECTRIC & PUMP Co., Centerville, Calif., A. S. Enos proprietor, has again undertaken distribution of Byron Jackson Pumps.

CHADWICK MACHINERY Co., Milwaukee, Wis., has been appointed distributor for the Link-Belt Co., Chicago, Ill.

M. N. DANNENBAUM Co., Houston, Texas, has been appointed district representatives for the Coppus Engineering Corp., Worcester, Mass.

FULLER Co., Catasauqua, Pa., has opened a district office at 564 Market St., San Francisco, under Jose M. Alonso, formerly manager of Chicago office.

GAIR BOSTON CONTAINERS, INC., has acquired the Corrugated Container Division of Sherman Paper Products Corp. The Medford plant and container sales office of Gair Boston Containers, Inc. will move to Newton Upper Falls, where the Sherman plant is located.

GALE ENGINEERING Co., 136 Liberty St., New York, N. Y., has been appointed representative for the Combustion Control Division, A. W. Cash Co., Decatur, Ill.

GREEN FUEL ECONOMIZER Co., Beacon, N. Y., has been licensed by Foster-Wheeler Corp., New York, N. Y., to manufacture an extended-surface economizer under Foster-Wheeler patents.

HARRIS-GREEN Co., 1101 Farmers Bank Bldg., Pittsburgh, has been appointed representative in western Pennsylvania for Louis Allis Co., motor manufacturer of Milwaukee, Wis.

LINK-BELT Co., 910 S. Michigan Ave., Chicago, Ill., has moved its Portland, Ore., warehouse to 14th Ave. & Savier St., where the company's local sales office will also be.

CLYDE J. HARRISON Co., Minneapolis, Minn.; K. R. Ackerman, Philadelphia, Pa.; Fred S. Renauld Co., Los Angeles, Calif.; Engineering Service & Supply, Inc., San Francisco, Calif.; F. L. Nisonger, Portland, Ore.; Palmer-Shile Co., Detroit, Mich., have been appointed agents of W. H. Nicholson & Co., Wilkes-Barre, Pa.

HUNGERFORD & TERRY, INC., Clayton, N. J., has elected the following officers: chairman of the board, Churchill Hungerford; president, Churchill Hungerford, Jr.; vice-president, Sereno F. Alling; secretary & treasurer, Harris D. Geschwindt.

NEW ENGLAND POWER ASSOCIATION system has transferred three operating engineers to new posts. Stanley W. Stoddard, former superintendent, northeastern division, has been made superintendent of central division with offices at Worcester, Mass. He is succeeded at Lawrence, Mass. by John W. Keeney, superintendent of southern division at Providence, R. I. Treffly C. Capistron, former superintendent of the central division, has been transferred to Providence.

REPUBLIC STEEL CORP., Youngstown, Ohio, has moved its Seattle, Wash., district sales office to the White-Henry-Stuart Bldg.

SELAS Co., Philadelphia, has engaged W. M. Smith, 50 Church St., New York, N. Y., to manage engineering and sales activities in the New York area.

SHALLCROSS CONTROLS, 3707 North Richards St., Milwaukee, Wis., has appointed the following sales agents: General Instruments & Controls Co., Chicago, Ill.; W. O. Taylor & Co., Ltd., Montreal; Kennedy B. Whitley, Erie, Pa.; Walter V. Gearhart Co., Atlanta, Ga.; P. C. Heckmann Co., Cincinnati, Ohio; Morrissey-Kantenberger Co., Dallas, Tex.; James F. Strachen, Berkeley, Calif. and J. R. Fortune & Son, Detroit, Mich.

STANDARD FUEL ENGINEERING Co., Detroit, Mich., has appointed E. B. Packard Co., 30 Church St., New York, N. Y., representatives in the New York territory.

STEAM EQUIPMENT MFG. Co., Jenkins Arcade Building, Pittsburgh, Pa., has been appointed distributors for Ashton Valve Co., Boston, Mass.

WESTINGHOUSE AIR CONDITIONING DEPT. has been transferred from East Pittsburgh, Pa., to Mansfield, Ohio, where it becomes a part of the Merchandising Division.

NEW BULLETINS

(Further bulletins on page 512)

Knife Switches — General Electric Co., Schenectady, N. Y.—Bulletin No. GEA-2127, 4 page leaflet giving the dimensions and details of large size knife switches.

Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin No. W-321-B2A showing the construction, dimensions and capacities of small-size centrifugal pumps.

Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin No. W-102-B1. 6-page folder gives dimensions, specifications and ratings for a line of horizontal-duplex piston pumps.

Resistors—Ohio Carbon Co., 12508 Berea Road, Lakewood, Ohio. Folder describing low-resistance carbon resistors used for increasing the sensitivity range of certain types of electronic control apparatus. Graphs illustrate operating characteristics.

Spray Nozzles—Binks Mfg. Co., 3114-40 Carroll Ave., Chicago, Ill. Bulletin No. 50. 8-page, 2-color booklet contains data and selection charts for applications of spray nozzles.

Thermometers—Leeds & Northrup Co., 4900 Stenton Ave., Philadelphia, Pa. Bulletin No. 4001. 24-page booklet giving compelte information on 3-lead, null-type, electrical-resistance thermometers for use in regulating an air-conditioning system.

Tools — Bonney Forge & Tool Works, Allentown, Pa. Catalog No. 35. 48-page leaflet printed in two colors presenting wrenches and tools with descriptions and prices.

Water Heaters—American District Steam Co., North Tonawanda, N. Y. Bulletin No. 35-75, 10 pages, illustrates and describes storage-type water heaters, with information for the estimating of hot-water demand.

V-Belt Drives—The Gates Rubber Co., Denver, Colo. 48-page bulletin No. DH-300 contains data for care and design.

Conveyors—Palmer-Bee Co., Westminster and G.T.R.R., Detroit, Mich. 64-page illustrated Section 107 of General Catalog 100 gives dimensions and capacity data for screw or spiral conveyor machinery.

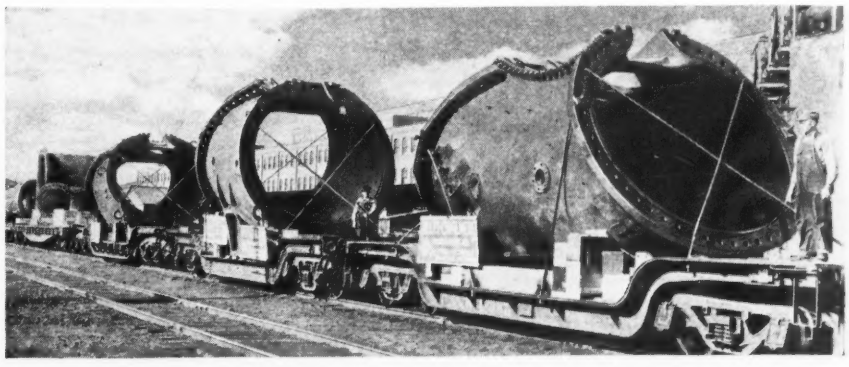
Sound Insulation—Johns-Manville, 22 E. 40th St., New York, N. Y. Illustrated booklet No. DS Series 275 discusses problem of sound control in air-conditioning systems.

Voltage Regulators—Simplex Corp., Burlington, Iowa. Bulletin No. 201 illustrates a number of recent installations and describes line of voltage regulators for use in plants up to 50,000 kw.

Condensate—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin No. W-321-B6 illustrates line of condensate-return units for building and plant service.

Insulation — Johns-Manville, 22 E. 40th St., New York, N. Y. 64-page pocket-size booklet describes and illustrates insulating products and uses of each.

Pumps — Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass. Bulletin No. 204 describes construction and illustrates series of high-duty multi-stage pumps for waterworks, boiler plants, etc.



Six carloads of elements for a spiral casing for one of the 115,000-hp. Boulder Dam turbines leaving the Allis-Chalmers plant. Each turbine will weigh 1¾ million pounds, will require 26 cars to carry it. Water flowing through this turbine would be enough to supply Detroit

STRAWS

Pointing the way business winds blow

JOHN MORREL & Co., Ottumwa, Iowa, is installing a 200-lb. pressure (design pressure 450 lb.) 100-deg. superheat pulverized coal-fired Combustion Engineering boiler to burn Iowa coal with suspension-type burners. The $150,000 boiler is 21 ft. wide, 22 ft. deep and 45 ft. high. It is a 4-drum bent-tube unit with water walls on all four sides. Capacity is 100,000 lb. of steam per hour with a peak output of 120,000 lb. Operating pressure may be raised later to produce by-product power. Coal carried by conveyors from railroad car to roof bunkers is then fed by gravity to a pair of 120-hp. motor-driven Riley pulverizers. Induced- and forced-draft fans are driven by 150-hp. steam turbines. Ash which drops is collected by a pneumatic conveyor, but the majority is caught in series of Prat-Daniel traps between boiler and stack.

PAINESVILLE, OHIO, is considering construction of a municipal steam power plant for central heating for public buildings and other downtown structures. Proposed to arranged Federal financing for $150,000.

BOSTON, MASS., Post Office contract has been awarded to Union Iron Works for two 3,000-sq.ft. 3-drum, bent-tube boilers and one 6 x 150-ft. steel stack.

ARIZONA HIGHLINE RECLAMATION ASSN., Phoenix, Ariz., has plans for Glen Bridge-Verde highline irrigation and power system. Project will include power dam at Glen Canyon, using water from Bill Williams River. Fund of $350,000 being arranged through Federal aid. Fred T. Colter, president.

PAULS VALLEY, OKLA., has secured a PWA loan and grant of $257,000 for a municipal electric plant. List of equipment to be installed is being arranged. V. V. Long & Co., Colcord Bldg., Oklahoma City, Okla., consulting engineers.

GUEYDAN LIGHT & POWER Co., Gueydan, La., has plans for steam-operated electric plant, with ice-manufacturing plant adjoining. To cost close to $40,000, with equipment. Charles A. V. Evans, superintendent, in charge.

KINGSTON PRODUCTS Co., Kokomo, Ind., has plans for one-story boiler plant at automotive equipment manufacturing works, to cost about $25,000. Oscar Cook, Armstrong-Landen Bldg., Kokomo, architect.

TAYLOR PRODUCE Co., Jackson, Mich., has plans for new one-story cold storage and refrigerating plant. Begin construction in September. To cost about $30,000.

PORT LAVACA, TEX., has a Federal loan and grant for $140,600 for municipal power and ice-manufacturing plant. Work under way early in the fall. Includes 2-story power house, 120 x 180 ft., with two 93.5-kva. generators direct-connected to gas engines. Ice-making division will be equipped for 20 tons per day. Complete program will cost about $190,000, balance of fund through municipal financing. Garrett Engrg. Co., Houston, Tex., consulting engineer.

KIRKSVILLE, MO., has plans under way for municipal electric plant, including distributing system. Project to cost about $450,000. Financing through Federal aid. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

BUREAU OF SUPPLIES & ACCOUNTS, NAVY DEPT., Washington, D. C., receives bids until Sept. 10 for a number of motor-generator sets, control appliances and spare parts for Navy Yards (Schedule 5770).

PACIFIC GAS & ELECTRIC Co., San Francisco, Calif., has authorized welded steel pipeline for increased natural gas service. 22-in. pipe and constructed by the Standard Pacific Gas Line, Inc., affiliated organization. Over $1,000,000; work begins late in September. Contract for pipe placed with Western Pipe & Steel Co., San Francisco.

MCMECHEN, W. VA., is considering municipal electric plant. Surveys and plans by J. M. Jenckes, McMechen, electrical engineer. Cost close to $100,000. Financing through Federal aid.

MICHIGAN CARTON Co., Battle Creek, Mich., has awarded building contract to Dean Murray, Battle Creek, for a boiler plant, to cost about $30,000. Shreve, Anderson & Walker, Book Bldg., Detroit, Mich., architects.

METROPOLITAN WATER DISTRICT, 306 West Third St., Los Angeles, Calif., receives bids until Dec. 3 for centrifugal pumping units and complete auxiliary equipment for main pumping stations of Colorado River Aqueduct, as per Specifications No. 116. F. E. Weymouth, general manager and chief engineer.

BURLINGTON, KAN., has taken bids for municipal light and power plant, and will begin work early in fall. Diesel engine-generating units, with fuel oil tanks, pumping machinery, etc. Fund of $145,000 through Federal aid. E. T. Archer & Co., New England Bldg., Kansas City, Mo., consulting engineers.

GISHOLT MACHINE Co., Madison, Wis., has plans for 1-story addition to boiler plant. Cost close to $25,000.

TRENTON, MO., will soon break ground for municipal electric plant. Injunction proceedings dismissed by Federal Court. $315,000 financing arranged through Federal aid. Diesel engine-generator units as prime movers. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

KEUFFEL & ESSER, New York, have air-conditioned their accounting department and five private offices with a system designed by Abbott Co. Condensing equipment consists of two Westinghouse units of 40-hp. each.

MIDDLE LOUP PUBLIC POWER & IRRIGATION DISTRICT, Loup City, Neb., J. E. Bowman, president, has Federal loan and grant of $2,000,000 for hydro development. Dam on Loup River, about 4½ m. south of Comstock, Neb. Two large electric-operated pumping stations will be built at Woo Park and Lee Park. Bids in near futur Henningson Engrg. Co., Union State Ban Bldg., Omaha, Neb., consulting engineer.

VERNON, IND., has authorized a bond issue of $60,000 for artifical gas plant, and will call for bids for equipment at earl date. Herman Bray, mayor, in charge.

VALLEY PIPE LINE Co., Dallas, Tex., is beginning a new 5½-in. welded steel pipeline from Sam Fordyce oil field to Port Isabel Tex. Cost about $400,000, with pumping stations. Contract awarded to Fredell Construction Co., C. A. Johnson Bldg., Denver Colo. Pipe let to Republic Steel Corp.

HYDROELECTRIC power development on Cosumnes River, tributary of Mokelumne, Amador County, Calif., is proposed by interests represented by Raymond Silva, Sacramento, Calif. Power dam will be constructed initial capacity 13,360 hp. Estimated cost $5,700,000.

LUBBOCK, TEX., has a Federal loan and grant of $112,500, to be used for extensions and improvements in municipal diesel plant.

STAPLES, MINN., has plans for addition to municipal steam plant for central heating. Bids soon. Fund of $82,000 arranged.

SAN DIEGO, CALIF., is planning a water expansion and improvement project to cost about $1,000,000. New water towers, pumping stations and filter plants. Fred Pyle, hydraulic engineer, in charge.

FAFNIR BEARING Co., New Britain, Conn., has plans for 1-story addition to boiler plant, about 20x50 ft., to cost about $25,000. Work under way at once.

BURLINGAME, KAN., has plans for municipal electric plant, estimated to cost $50,000. Financing through Federal aid. 300-hp. generator and auxiliary equipment. Bids in the fall. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

SPOKANE, WASH., has plans under way for electric-operated pumping station in South Side district for municipal waterworks. Bids will be asked soon. Fund of $330,000 being arranged. Frank G. Sutherlin, Commissioner of Public Utilities.

HIBBING, MINN., has plans maturing for extensions in municipal electric plant, including 2,500-kw. turbine-generator unit and accessory equipment, to replace two 500-kw. generators. Cost about $90,000. Financing through Federal aid. Burlingame & Hitchcock, Sexton Bldg., Minneapolis, Minn., consulting engineers.

KINGS COUNTY ICE & FUEL Co., Brooklyn, N. Y., has contracted for refrigeration equipment for a new 112-ton ice plant including a 10 x 10-in. duplex 4-cyl. York compressor driven by a 225-hp. motor.

ROUGE PLANT (Ford Co.), Dearborn, Mich., boiler construction is expected to be completed in three months and turbine-generators installed in about seven.

R. J. REYNOLDS TOBACCO Co., Winston-Salem, N. C., is completing new steam-electric power plant. New plant will have a rating of 10,000 kw., consisting of a new 7,500-kw. non-condensing turbine-generator unit furnished by General Electric Co., and a 2,500-kw. turbine-generator heretofore in service. The steam-generating plants consists of a battery of six cross-drum watertube

boilers, with capacity of 360,000 lb. of steam per hr. J. E. Sirrine & Co., Greenville, S. C., consulting engineers.

ALICE, TEX., has plans under way for municipal electric plant. Project to cost close to $200,000. Financing through Federal aid.

WEBSTER CITY, IOWA, plans extensions and improvements in municipal gas plant. A fund of $35,000 is being arranged.

BLAIR, NEB., has surveys under way by Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers, for a municipal electric plant. To arrange necessary financing soon.

MOBILE GAS SERVICE CORP., St. Francis St., Mobile, Ala., is planning artifical gas plant at Toulminville, Ala., where franchise has been secured. Pipeline system will be built. Cost over $85,000. Permission secured from Public Service Commission.

WYNNEWOOD, OKLA., has a federal grant and loan of $65,000 for municipal electric plant, and will have plans at once. Work scheduled to begin early in the fall. V. V. Long & Co., Colcord Bldg., Oklahoma City, Okla., consulting engineers.

GRAND FORKS, N. D., has appointed a committee to make surveys for a proposed municipal electric plant. Financing will be arranged through Federal aid. E. L. Lium, city engineer.

ALTAMONT, ILL., is arranging for $45,000 through Federal aid for extensions in municipal electric plant, including new equipment.

BOARD OF COUNTY SUPERVISORS, Crystall Falls, Mich., is considering new steam plant for central heating service for public buildings. Estimates soon. Financing through Federal aid.

LA PORTE, IOWA, has awarded contract to Monroe Electric Co., 228 North LaSalle St., Chicago, Ill., for diesel generating units and auxiliary equipment for municipal electric plant. Work under way at once, cost about $100,000. Young & Stanley, Muscatine, Iowa, consulting engineers.

REVELSTOKE, B. C., has started clearing right-of-way and ground at power-house in preparation for surge tank and laying of flume to connect tank with power units. $28,000 project will take approximately three months to complete. J. G. Knight, Vancouver, B. C., is engineer.

NATURAL GAS CORP., Boundary Bay on Washington, B. C., border is installing a generator and wiring plant for electric lighting under its own steam power to facilitate 24-hour-per-day operation to commerce when cement placed at the setting of the 1,745 ft. of $10\frac{3}{4}$-in. seamless steel casing hardens.

SOUTH NORFOLK, VA., has plans under way for a municipal electric plant. To include diesel-generator units with accessories, boilers, distribution system, etc. Wiley & Wilson, Lynchburg, Va., consulting engineers. C. H. Hughes, directors of Public Works.

MLLE. GERMAINE, 711 Fifth Ave., New York, N. Y., has installed an air-conditioning system which utilizes a 10-hp. compressor providing refrigeration equivalent to 10 tons of ice in 24 hours, and distributes 4,000 cu.ft. of air per min. General Electric equipment was installed by Schwerin Air Conditioning Corp., New York, N. Y.

U. S. PUBLIC HEALTH SERVICE is planning a nation-wide survey of plumbing systems of federal buildings, to be financed from relief funds. Particular attention will be given to the discovery of cross-connections between pure and polluted water services.

HOWARD, R. I., has awarded a contract for a 5,000-sq.ft. boiler with stoker for state-owned power plant.

RHODE ISLAND State Sanitarium at Wallum Lake will install a 1,750-sq.ft. boiler with feedwater heater, pumps, piping, etc.

DANVILLE, VA., has been allotted $1,237,909 by the Public Work Administration for construction of a dam and storage reservoir, diversion dam, pipeline, tunnel and penstock to 12,500-kw. hydro plant.

PROCTER & GAMBLE MFG. CO., has installed a Babcock & Wilcox 450-lb., 850-deg. boiler and generating plant. Steam used in heating soap is desuperheated before entering turbine steam line.

DELTA, COLO., has received $197,000 for a steam-electric plant and distribution system of Western Colorado Power Co. from PWA.

PAULS VALLEY, OKLA., has received $212,000 from PWA for a steam-electric plant and distribution system.

LUBBOCK, TEX., has received $112,500 from PWA for an addition to its present plant.

IOWA CITY, IOWA, has been allotted $413,000 by the Public Works Administration for the construction of a steam-electric power plant, including three 3,000-sq.ft. boilers, two 3,000-kw. generators and distribution.

RENO COUNTRY CLUB, NEV., has installed a year-round, split system, air-conditioning plant comprising three GE oil furnaces for heating, a 20-hp. compressor for refrigeration, 12 unit evaporators for cooling and dehumidification, and three $1\frac{1}{2}$-hp. fans.

PHILLIPSBURG, KANS., has received $120,450 from PWA for a diesel-electric plant and distribution system.

WYNNEWOOD, OKLA., has received $65,000 from PWA for a diesel-electric plant.

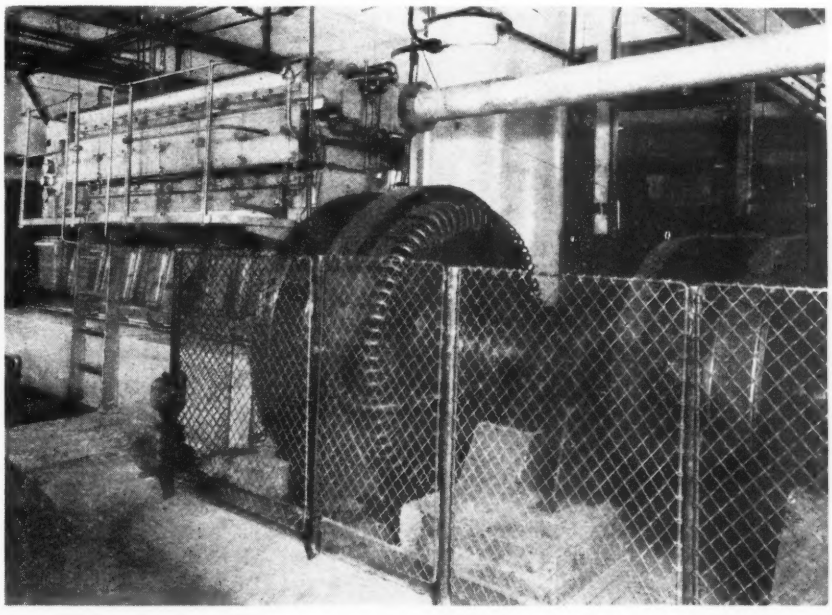
COQUITLAM, B. C., Boys Industrial School will be completed by Pacific Engineers, Ltd., Vancouver, B. C., according to a contract

FORD MOTOR CO. is installing temperature regulation and air-conditioning equipment in its Rouge factory, which contains 275,000 cu.ft., of building. Air-conditioning is now being installed in the executive and other offices of the company at Dearborn.

BRISTOL, R. I., sewage disposal pumping installation comprising two 4-in. Morris Machine Works non-clog 400-g.p.m. pumps at Oliver St. station, two 6-in. g.p.m. at Constitution St., and three 8-in. 1200-g.p.m. units at Main Station has been completed by Starkweather Engineering Co., Boston, Mass.

CITY OF LOS ANGELES, Bureau of Power & Light, has ordered two hydrogen-cooled, 60,000-kva., 13,800-volt, 60-cycle synchronous condensers from the General Electric Co. and one from Westinghouse.

CITY OF KEENE, N. H., has contracted with Starkweather Engineering Co., of Boston, Mass., for a sewage pumping works involving two 10-in. Morris 2,500-g.p.m. non-clog pumps, piping, valves, etc., 50-hp. Ideal motors, and Sundh control board.



OIL MAKES GAS

This plant generated 525,000 kw.-hr. at a fuel and lubricating oil cost of 4.67 mills per kw.-hr. (total cost 9 mills) during one month last year, working 20 days, 24 hr. a day. Rated 275 hp. at 300 r.p.m., the 6-cyl. solid-injection Cooper-Bessemer diesel drives a generator direct and a 4-stage air compressor by belt for Gas Products Co., Columbus, Ohio, makers of oxygen and acetylene gas. Power costs have been halved with the diesel

FISH STORIES

"Yessir, had that there fish—all of a foot and a half long he was, too—right up close to me. Reached out with my landing net, and just then he flipped off my hook. Got clean away; biggest trout ever seen around these parts, too!"

That's an old yarn that varies only with the teller and place—the fish that got away is always the "biggest and bestest." Every last one of us believes his fish would meet the specifications he's laid down for him—if he only hadn't got away.

But aren't we all just a little scared that maybe the fish wouldn't have measured up if we'd caught him? Uncaught, that fish is legend. Had we hooked him solidly he might have turned out to be just a hair over the legal minimum.

Maybe you think doubts like that are only for fishermen (in case you don't fish). But do you, way down inside yourself, believe the dentist who says it won't hurt, the doctor who says everything will be all right, the boss who says "he'll see what he can do," the salesman who swears his stuff will do so-and-so? You're darn well right you don't.

Oh, you'll swear you believe it, and maybe consciously you do, but if you're anything like me, way down inside you're another doubting Thomas. We kids used to scorn "scaredy cats" who wouldn't follow the leader, but just the same we were just scared enough ourselves to think that maybe the scaredy cat had the right dope.

Maybe this explains why so many of us pull our punches when it comes down to a cold statement of fact on how much new equipment will be worth. We hem and haw, talking about how firm our belief in the investment is, yet mentally hedging just as surely as does the race-track tout who lays bets on a half dozen horses to be sure one of them wins. We're just a little afraid that that particular fish will get away, that our dope wasn't quite straight.

Probably all this explains why I am attracted to an ad from *Power* in June that started out with "Result Stories," and listed seven plants that bought meters, and told how much they'd paid for 'em and how much they saved. And I've been clipping a stoker series too, to say nothing of the others that give dollars-and-cents dope on equipment I will be buying some day soon.

What good are they to me? Just to convince me that the fish isn't on the wrong end of the pole when I plan to put in new meters, or new stokers. Just to give me names and places on which to check. First I've got to convince myself. Then the dope will help me convince the Boss. And concrete results that somebody else got go a long, long way toward doing just that.

They keep me from pulling my punches when I'm out to modernize, and more of 'em will keep me and other engineers from pulling theirs in future. I wonder just how many engineers are hesitating to recommend definitely a purchase of new equipment in the fear that they made a mistake in figuring? Just how many are afraid to get an appropriation or an FHA-guaranteed loan that will step up efficiency for fear returns won't meet their estimates? Result stories are the answer to that one — result stories with facts and figures.

Seems to me that a good thing for us engineers to do is to get result stories ready. Incidentally, it might be wise for power equipment makers to give us that kind of data. Not fish stories, but good, sound facts that will help us make up our minds when the time comes.

George Edwards

GEORGE EDWARDS
Engineer

For any reversing or other 2-function duty up to 2 h.p.

A year ago such motor control was twice this size. Brings true C-H Motor Control, new speed and simplicity, and new sales appeal to hundreds of factory, office and domestic machines.

NEW COMPACT TWO-MOTION CONTROL

BULLETIN 9441 Type V1

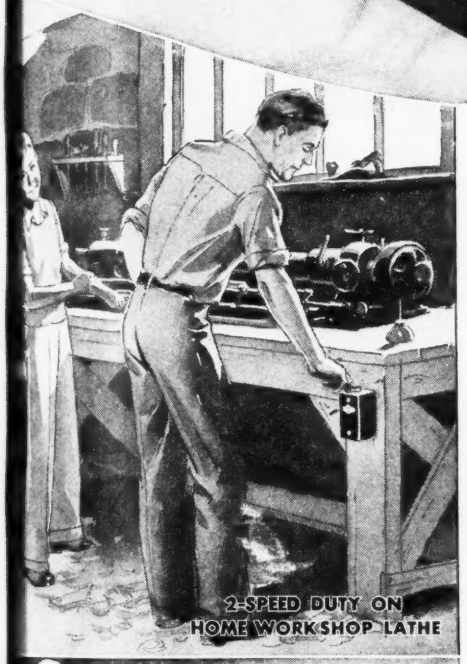
•

500 USES SO FAR— WHAT CAN YOU DO WITH IT?

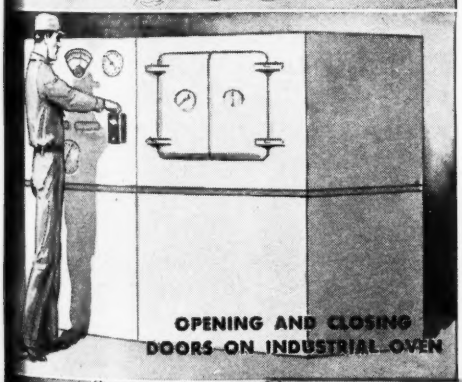
Scaled down in size, scaled up in performance, rugged enough for any industrial use, an improvement and a sales asset on any machine

NOW the Motor Control Leader produces another leader in control devices—the Bulletin 9441 Two-Motion Control. Nothing like it ever before . . . incorporates in a drum type control the famous features of C-H Automatic Starters. Provides simple manual control of motorized machines having two functions, i.e.: low and high speed plus off; forward and reverse plus off; manual and automatic plus off; etc. Read these advancements:

Twin-break contacts with high arc-rupturing capacity, and arc barriers. No flexible connections. No current-carrying contact springs. Self cleaning contacts. Contact parts replaced without tools. Has removable handle. Non-projecting handle insures against accidental operation. . . . Three operating positions positively indicated by star-wheel inside enclosing case. . . . Finger board at front of mechanism simplifies wiring; body is arranged for conduit wiring. . . . Rating: 15 amps. continuous duty. A.C. rating: 3-phase 1½ h.p., 110 volts; 2 h.p., 220, 440, 550 volts. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* **1358** St. Paul Ave., Milwaukee, Wis.

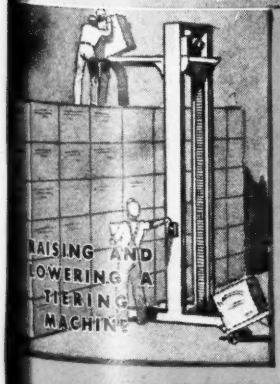


2-SPEED DUTY ON HOME WORKSHOP LATHE

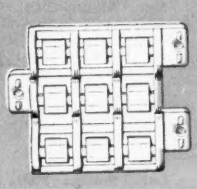


OPENING AND CLOSING DOORS ON INDUSTRIAL OVEN

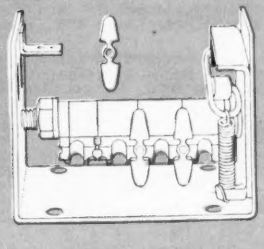
TO MACHINE BUILDERS: Ingeniously arranged for top, surface or cavity mounting. Extremely easy to wire and service. Attractive modern styling, compact, and simple to use. Plates for Forward and Reverse, Low and High, etc., available. Spring return feature providing momentary operation when held down, as for inching, available. Special enclosing plates and covers for built-in installations, available. Ask for test sample on company letterhead.



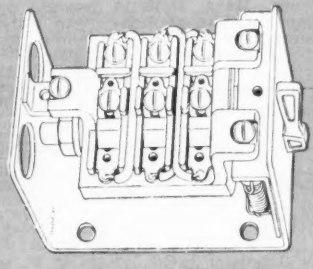
RAISING AND LOWERING A TIERING MACHINE



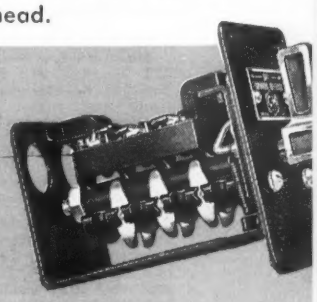
Stationary contacts, removable as a unit.



Movable contacts, changed without tools.



Cover removed, showing ease of wiring.



Skeleton type 9441 with adapter plate for cavity mounting.

CUTLER-HAMMER C-H MOTOR CONTROL

SEE CUTLER-HAMMER EXHIBIT . . . BOOTH E-201 . . . 1935 MACHINE TOOL SHOW . . . CLEVELAND . . . SEPTEMBER 11 TO 21

NEW BULLETINS

Air Conditioning Equipment—Julien P. Friez & Sons, Inc., Baltimore, Md. Two 4-page folders. Bulletin G details portable recording instruments for relative humidity, temperature, etc. Bulletin K is a condensed catalog of air-conditioning products including Humidistats, humidity and temperature indicators, thermostats, etc.

Bonding Mortars—Harbison-Walker Refractories Co., 1801 Farmers Bank Bldg., Pittsburgh, Pa. Three folders describing three types of high-temperature bonding mortars, chrome-ore base, silica base and diaspore base, and the applications for each.

Cable Accessories—General Electric Co., Schenectady, N. Y. Bulletin No. GEA-1839. An 80-page catalog gives complete data on a line of cable accessories including joints, terminals, oil reservoirs and other accessories for jointing, splicing and terminating insulated cable on electric power circuits.

Compressors—Carbondale Machine Corp., Harrison, N. J. 12-page booklet covering a line of horizontal single and duplex compressors, of single-stage and two-stage types, steam driven and motor driven. Bulletin No. 1100.

Compressors — Ingersoll-Rand Co., 11 Broadway, N. Y. 48-page, profusely illustrated, catalog describing in great detail Type XPV steam-driven air or gas compressor. Also a 32-page catalog covering a line of "Type 30" industrial compressors and vacuum pumps, ¾ to 15 hp., pressures up to 1,000 lb.

Compressors—Worthington Pump & Machinery Corp., Harrison, N. J. 4-page leaflet describing single-stage vertical air compressors. Bulletin No. L-621-B6.

Conduit System — H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J. Bulletin No. 351. A profusely illustrated 8-page folder showing a system of protection and insulation for underground pipelines.

Conveyors—Chain Belt Co., Milwaukee, Wis., 28-page folder shows in picture form various types of materials-handling equipment and their application in certain specific industries.

Diesels—Caterpillar Tractor Co., Peoria, Ill. Five folders covering the application of diesel power units to a wide variety of installations including diesel-electric generating sets and a diversified list of machines.

Flowmeters—Cochrane Corp., Philadelphia, Pa. Bulletin No. 701 describing the principle and method of operation of electric flowmeters for steam, liquids and gases.

Fuse Switches — General Electric Co., Schenectady, N. Y. Bulletin No. GEA-2123, 4-page folder illustrating and giving the ratings for outdoor, drop-out fuse disconnecting switches.

Gages—Hays Corp., P. O. Box 299, Michigan City, Ind. Catalog PGA-35 covering a line of dry-type pointer draft gages, inclined-tube, direct-reading, U-tube and vernier-scale gages and dry-type draft recorders.

Generators — Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin No. 1171, 12 pages, illustrating the construction of special d.c. generators with particular emphasis on armature windings and the accompanying switchboards.

Metal Atomizer—Coen Co., 30 Vesey St., N. Y. 4-page illustrated folder explaining the process of applying sprayed molten metal and showing the equipment needed.

Mortar Bonds—Ironton Fire Brick Co., Ironton, Ohio. Information circular No. 3 gives chemical and physical properties and uses of a high-temperature cement.

Pumps—Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass. Bulletin No. 201 describes the construction, applications and range of capacities of double-suction, horizontally split pumps.

Rectifiers—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin No. 1169, 12 pages, describing the construction, operation and uses of mercury-arc power rectifiers.

Rubber Goods—Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J. 56-page catalog describing belting, hose, fittings, packing, friction material and various types of molded rubber goods.

Steam Traps—W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa. 4-page folder giving dimensions, capacities and prices of industrial steam traps.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Luxera — Municipality, plans electric light and power plant. $80,000. W. F. Moody & Co., National Standard Bldg., Little Rock, archts. and engrs.

Calif., Lodi—City, election Sept. 12, $466,000 bonds which will be supplemented by P.W.A. grant of balance of estimated $600,000 cost for hydro-electric plant on Mokelumne River and diesel stand-by plant in city limits.

Calif., Los Angeles—Bids Dec. 3, by Directors Metropolitan Water Dist., F. E. Weymouth, engr., 306 West 3rd St., furnishing centrifugal pumps for main pumping plants of Colorado River Aqueduct, Spec. 116, 3 pumps for each of 5 pumping plants, as follows: main pumping plant along aqueduct, incl. Colorado River plant, 290 ft. lift, Gene Wash plant, 303 ft. lift, Iron Mt. plant, 147 ft. lift, Eagle Mt. plant, 438 ft. lift, Hayfield plant, 440 ft. lift, each of the plants to contain three sec.-ft. pumps at first and 9 ultimately. Each bidder to submit model pump to be tested by District, test to meet specification requirements. Est. $500,000 for pumps. Total est. of pumping plants, $14,559,000.

Calif., Wilmington—Vegetable Oil Products Co., 6100 Avalon Blvd., Los Angeles, plans by A. C. Martin, 233 Higgins Bldg., Los Angeles, steel, concrete boiler house. To exceed $28,500.

Conn., Norwalk—Norwalk Hospital, plans by A. Schultz, archt. and engr., 36 Euclid Ave., altering heating plant and power house. $29,000.

D. C., Wash. — Bids Sept. 4, by District Comrs., District Bldg., constructing units 5-10 sewage treatment plant at Blue Plains, incl. sludge dewatering power plant and administration buildings, substation. Metcalf & Eddy, Statler Bldg., Boston, Mass., engrs.

Ill., Altamont—City, plans improving light plant. Applied for $45,500 loan and grant. W. A. Fuller Co., 2915 Shenandoah Ave., St. Louis, Mo., engr.

Ill., Chicago — International Harvester Co., 606 South Michigan Ave., Chicago, plans by O. A. Krueger, 606 South Michigan Ave., 1 story, 50x120 ft., power unit. $75,000.

Ill., LaSalle — City plans construction light and power plant building and equipment. $750,000 revenue bond issue approved by voters.

Ind., Auburn—City soon takes bids 61x87 ft., brick, rein.-con., steel municipal waterworks and electric plant. L. Bradley, 221 West Wayne St., Fort Wayne, archt. C. McClinsock, city engr.

Ia., Hopkinton—Town, A. W. McDonald, clk., voted $67,800 bonds for municipal light and power plant bldg., incl. 350 hp. engine, etc. A. S. Harrington, P. O. Box 425, Omaha, Neb., engr.

Kan., Hoisington—City filed application with P.W.A. for loan and grant to finance construction power plant and distribution system. $150,000. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, Mo., engrs.

Kan., Strong City—City plans application to P.W.A. for funds to finance construction light plant, Diesel engine power. $55,000. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Mass., Worcester—City, J. C. Mahoney, mayor, City Hall, making studies electric light plant. Engineer not appointed.

Mich., Birmingham—City, H. Allen, mayor, retained Francis Engineering Co., Eddy Bldg., Saginaw, to prepare preliminary surveys brick, steel, rein.-con. municipal electric light and power generatng plant, plain found. To exceed $100,000.

Minn., Tyler — City plans purchasing light plant unit, 280 hp., for installation in municipal power and light plant. $31,000. J. D. Rix, city clk.

Mo., Hardin — City, B. Myers, mayor, plans electric generating plant. Applied for $13,750 loan and $11,250 grant from P.W.A. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Neb., Albany—City reports in progress power plant improvements. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

N. J., Vineland — Boro plans constructing municipal power station, incl. boilers, pumps, heater, turbo-generator, condenser, switchboard, transformers, regulators and auxiliary equipment, changes to spray pond and equipment. $598,600. Applied for P.W.A. funds. F. Daugherty, c/o Schofield Eng. Co., Commercial Trust Bldg., Phila., Pa., engr.

N. Y., Bolton—Bd. Supervs. Warren Co., Lake George, making surveys constructing power plant. Utilities Eng. Co., Inc., 1 Columbia Pl., Albany, engrs.

N. Y., Brooklyn—Bids Sept. 4, by Bd. Higher Educ., at office Brooklyn College, 383 Pearl St., constructing, plumbing, heating, ventilating, electrical work and lighting fixtures for heating plant and gymnasium, incl. pipe tunnel for Brooklyn College.

N. Y., Owego—Village, Village Hall, making surveys constructing municipal power plant. To exceed $35,000. Utilities Eng. Co., Inc., 1 Columbia Pl., Albany, engrs.

N. Y., New York—Dpt. Hospitals, Municipal Bldg., plans electric light and power plant, also laundry, at Neponsit Beach Hospital, Belle Harbor. $215,000.

N. Y., Savona—Lake Keuka Power Corp., Penn Yan, plans developing hydro-electric project at Savona and Wayne, incl. impounding waters of Lamoka and Waneta Lakes, etc. Private plans.

O., Barberton—Bd. Educ., M. S. Yoder, pres., plans completed 1 story, basement, 30x32 ft., brick central heating plant, incl. two 150 hp. water tube boilers, stokers, foundations. Est. $48,000. W. W. Leipner, 2036 East 22nd St., Cleveland, engr.

O., Grafton—Village, E. E. Arnold, pres. Bd. Pub. Affairs, plans election to vote on bonds and will apply for P.W.A. loan, 1 story, brick, steel concrete power plant, incl. 3 diesel engines, generators, water cooler and oil tanks. $45,000. W.P.A. project. Hadlow & Elwell, 5005 Euclid Ave., Cleveland, engrs.

Okla., Shawnee—City made preliminary plans 600 hp. engine generator set for Shawnee Water Plant. $60,000. T. E. Thompson, Shawnee, city mgr. and engr. W. R. Holway, Tulsa, consult. engr.

Okla., Pauls Valley — City plans new 1,000 hp. Diesel engine light plant, $212,000. M. G. Cox, Pauls Valley, engr. Loan and grant approved.

South Carolina—State of South Carolina plans building 2 dams and hydro-electric plant on Cooper and Santee Rivers, one near Manning and other near Pinopolis, also dredging rivers to make them navigable. $37,000,000. P.W.A. project. B. R. Maybank, Charleston, chn. of authority. Project approved by President Roosevelt. H. Flood, New York, and C. H. Moorefield, Columbus, engrs.

S. C., Spartanburg—City, comn. P. Wks., Dr. L. McD. Kennedy, chn., filed application with P.W.A. for funds to finance construction 67 ft. high, 800 ft. long dam on Pacolet River, to impound water in 10 mi. lake. $999,947. Lockwood-Green Co., Spartanburg, engr.

S. C., Westminster—City, L. H. V. Hobson, mayor filed application with P.W.A. for loan to finance hydro-electric development, construction of dam, power plant and installing transmission lines from plant to town. $114,500. Ryan Engineering Co., Columbia, engrs.

S. D., Plankington—State, c/o State Training School, Pierre, making plans steam power plant, furnishing, installing two 100 hp. and one 25 hp. power boilers, pumps and heaters. $55,000. Will seek federal funds. C. A. Trimmer, state engr. F. F. Kings & W. J. Dixon, Mitchell, archts.

Texas — Lower Colorado River Authority, Austin, bought half-finished Buchanan Dam, several thousand acres of land in the basin of its future lake and all hydro-electric power and water storage permits on the river and land at various dam sites, $20,000,000. Authority paid for this property out of the $20,000,000 federal loan and grant received by it from the Federal Government. Fegles Constr. Co., 711 Wesley Temple, Minneapolis, Minn., have been retained to complete the Buchanan Dam, four or five other dams to be built also. Fargo Eng. Co., engrs.

Tex., Alice—City, plans application to P.W.A. for $200,000 loan and grant to finance construction municipal electric light and power plant.

Alaska, Seward — Town, D. C. Brownell, mayor, plans constructing hydro-electric plant, incl. 420 hp. generating units and power house, 3 mi. square reservoir, constructing dam at outlet of Lost Lake, pipe line, flume or open channel to carry water. Hubbell & Waller, Alaska Bldg., Seattle, Wash., engrs.

Ont., Smiths Falls — Ontario Hydro-Electric Comm., plans addition to sub-station, purchase and installation of new transformers, etc.

Que., Rawdon — Gatineau Power Co. Ltd., 140 Wellington St., Ottawa, soon takes bids power plant. C. Gliddon, engr.